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FROGS, EGG TEETH, AND EVOLUTION: PRELIMINARY COMMENTS ON
EGG TEETH IN THE GENUS *ELEUTHERODACTYLUS*

Jerry D. Hardy, Jr.

Abstract

The egg teeth of 36 members of the genus *Eleutherodactylus* have been observed. Two kinds of egg teeth are known: Some have a single, median point; while others are bifurcate. Although the bifurcate egg tooth is evident in several different species groups within the genus, it occurs with remarkable frequency in the West Indian *auriculatus* group. In thirteen of fifteen members of this group for which the egg tooth is known, the egg tooth is bifurcate. The two exceptions, that is those members of the *auriculatus* group having a single-pointed egg tooth, both occur at or near the southern limits of the assumed range of the group.

The anuran genus *Eleutherodactylus* occurs in tropical and sub-tropical regions of North, Central, and South America, and on most of the West Indian Islands. It is among the largest of the anuran genera, and, consequently, its members show a remarkable degree of morphological and behavioral variation. One of the most significant unifying characteristics of this otherwise diverse group is the fact that development takes place entirely within the egg - a phenomenon which is generally referred to as "direct development" (Figure 1).

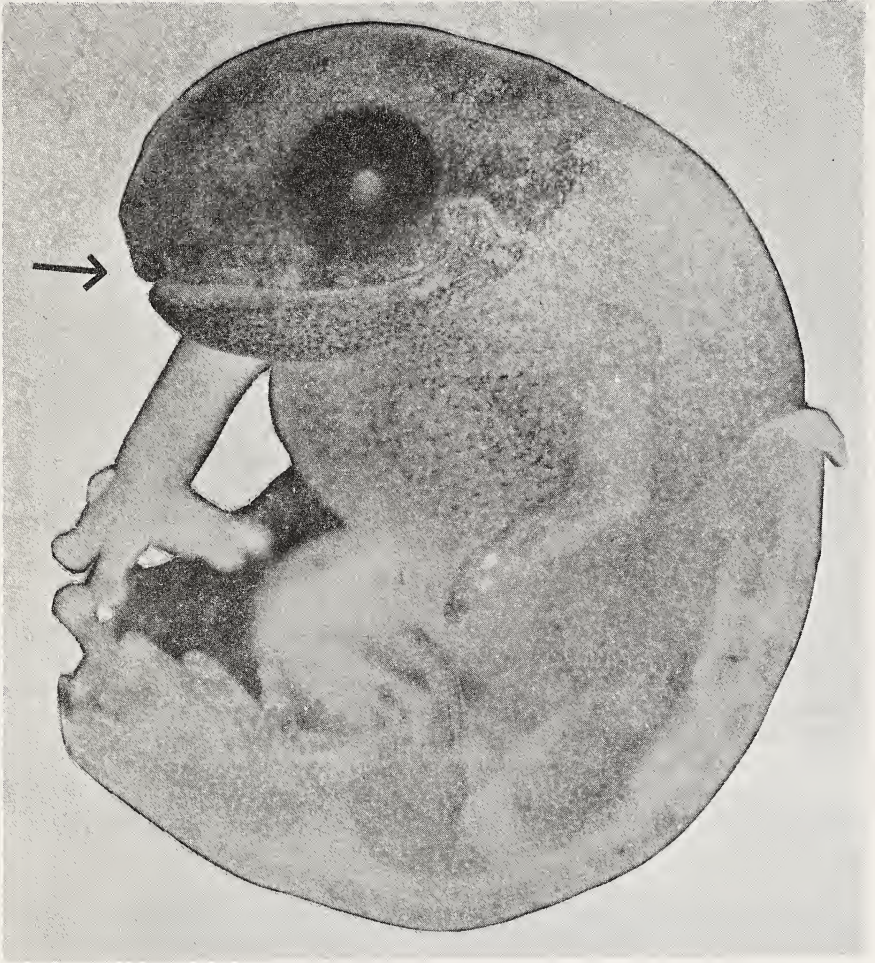


Figure 1. *Eleutherodaetylus coqui* at the time of hatching. The emerging froglet is fully developed, and there is no tadpole stage. Although the egg tooth (indicated by the arrow) is bifurcate in this species, it appears single-pointed in later view. (Photograph by Janet Olmon).

The eggs are deposited in a variety of terrestrial or arboreal habitats and may be unguarded, or guarded by either the male or female parent, depending on the species involved (Figure 2).

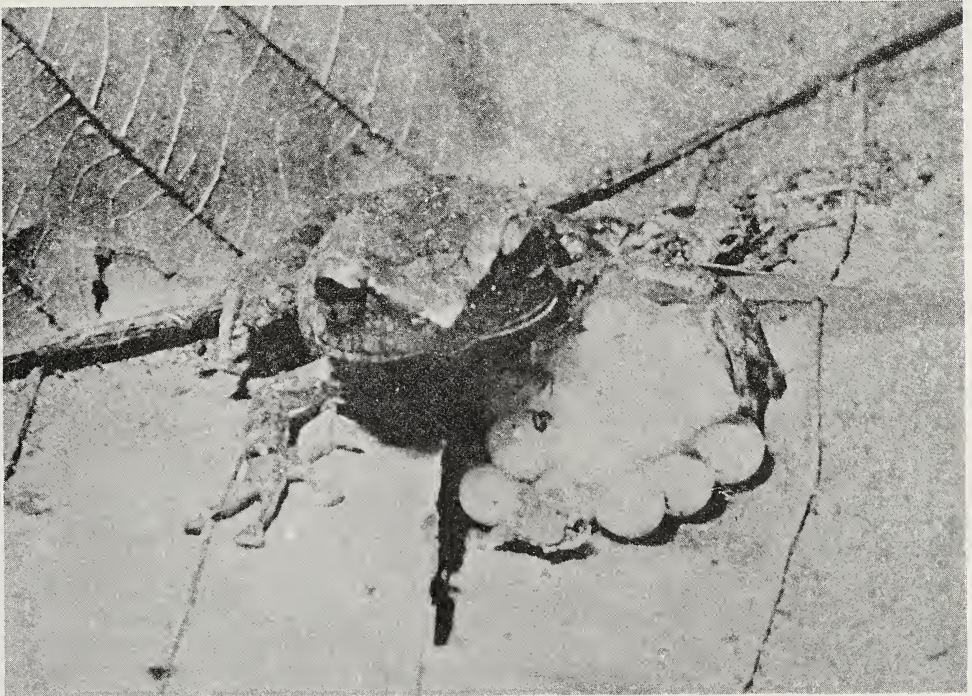


Figure 2. Guardianship of the eggs, *Eleutherodactylus coqui*, male. (Photograph by George E. Drewry).

Some years ago, at a time when my luck as a collector was better than it has recently been, I had the good fortune to find egg clutches of a number of species of *Eleutherodactylus* on certain of the islands of the southeastern Caribbean. At the same time, and by equally good fortune, my friend George Drewry was collecting and hatching eggs of a variety of kinds of *Eleutherodactylus* in Puerto Rico.

One day, while working with *Eleutherodactylus* eggs at the El Yunque Field Station in Puerto Rico, George, Janet Olmon, and I suddenly "discovered" that there were two kinds of egg teeth in the genus *Eleutherodactylus*: In some species the egg tooth was a single, median, sharply-pointed to bluntly-rounded structure; while in others it was distinctly bifurcate (Figure 3).

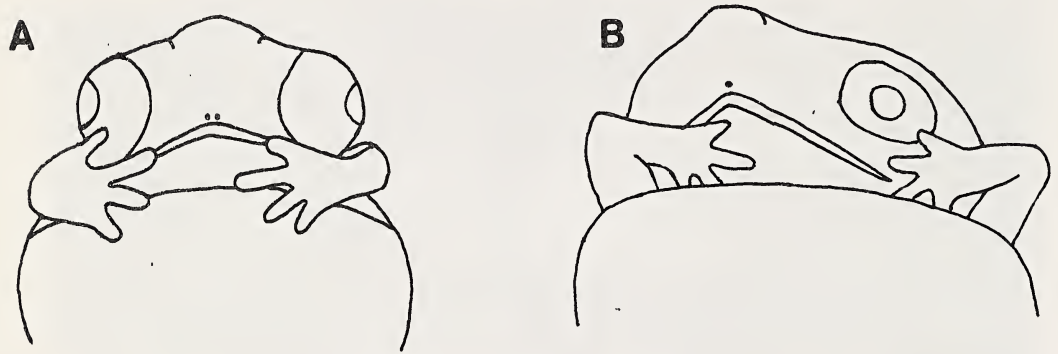


Figure 3. A. Bifurcate egg tooth, *Eleutherodactylus abbotti*. B. Single-pointed egg tooth, *Eleutherodactylus inoptatus*. (Redrawn and slightly modified from Noble, 1926).

Our "discovery" of course resulted from our own naivete; we did not then realize that Noble had twice noted and illustrated the same phenomenon (Noble 1926, 1931).

Noble found that, in *Eleutherodactylus abbotti*, in which the egg tooth is bifurcate, the eggs are sometimes deposited "among reeds in such a position as to be well protected from the rains" and that the young frogs rip their way out of the egg capsule, piercing "first the inner capsule and then the outer with [their egg teeth]"; whereas in *Eleutherodactylus inoptatus*, in which the egg tooth has a single, median point, the eggs are deposited in "shallow holes" where they are subject to rain soaking, hatching occurs only "with the application of water", and "the outer capsule [breaks] first, and the inner capsule only sometime later".

Among the specimens which we collected in the Caribbean we noted that in those eggs having a median, single-pointed egg tooth, the egg tooth was first evident (predictably) as a median point; whereas in those eggs having a bifurcate egg tooth, the egg tooth was first evident as two separate, bi-lateral points (Figure 4).

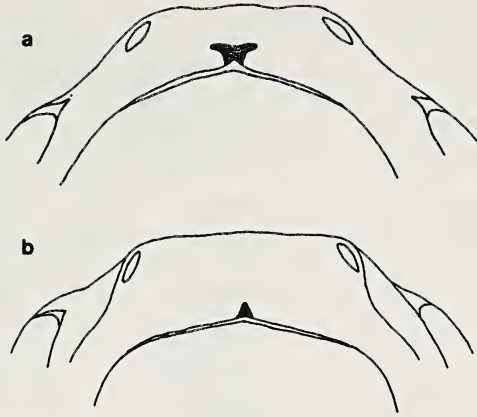


Figure 4. First gross evidence of developing egg tooth in: A, *Eleutherodactylus coqui*, B, *Eleutherodactylus richmondi*. (Drawings by Janet Olmon).

Since we were unable, at that time, to do histological studies we did not learn whether the egg tooth actually develops medially in some species and bi-laterally in others. It would certainly be remarkable, however, if this were true.

In looking at the eggs of the various species in our collection, it seemed clearly evident that in members of the *auriculatus* group (as characterized by Lynch, 1976) the egg tooth was bifurcate; while in non-*auriculatus* group species the egg tooth was single-pointed. That generalization was quickly dispelled once I began examining museum collections; but the resulting new information still strongly suggested a more than co-incidental occurrence of the bifurcate egg tooth in the *auriculatus* species group (Table 1).

TABLE I

<u>Bifurcate Egg Tooth</u>		<u>Single-Pointed Egg Tooth</u>	
<i>gryllus</i> (A)	Puerto Rico	<i>unicolor</i>	Puerto Rico
<i>coqui</i> (A)	Puerto Rico	<i>richmondi</i>	Puerto Rico
<i>portoricensis</i> (A)	Puerto Rico	<i>lentus</i>	St. Croix
<i>hedricki</i> (A)	Puerto Rico	<i>luteolus</i>	Jamaica
<i>cooki</i> (A)	Puerto Rico	<i>alticola</i>	Jamaica
<i>antillensis</i> (A)	Puerto Rico	<i>nubicola</i>	Jamaica
<i>locustus</i> (A)	Puerto Rico	<i>inoptatus</i>	Dominican Rep.
<i>jasperi</i> (A)	Puerto Rico	<i>urichi</i> (A)	Trinidad
<i>barlagnei</i> (A)	Guadeloupe	<i>terraebolivaris</i>	Tobago
<i>pinchoni</i> (A)	Guadeloupe	<i>martinicensis</i> (A)	Dominica
<i>johnstonei</i> (A)	Grenada	<i>planirostris</i>	Florida
<i>abbotti</i> (A)	Dominican Rep.	<i>affinis</i>	Colombia
<i>flavescens</i> (A)	Dominican Rep.	<i>cruentatus</i>	Panama
<i>jamaicensis</i>	Jamaica	<i>hylaeformis</i>	Panama
<i>grabhami</i>	Jamaica	<i>fitzingeri</i>	Panama
<i>decoratus</i>	Mexico	<i>ridens</i>	Panama
<i>Eleuthero.</i> sp.	Ecuador	<i>Eleuthero.</i> sp.	Panama
		<i>guntheri</i>	Brazil
		<i>Eleuthero.</i> sp.	Costa Rica

Table I. Occurrence of single-pointed and bifurcate egg teeth in members of the genus *Eleutherodactylus*. The symbol (A) indicates members of the *auriculatus* species group, while species lacking this symbol are non-*auriculatus* group members. Localities represent points of collection, not necessarily entire ranges.

A number of problems are immediately evident in Table I. Among these species having a bifurcate egg tooth, four (*E. jamaicensis*, *E. grabhami*, *E. decoratus*, and *Eleutherodactylus* sp. of Ecuador) are, according to current thinking, non-*auriculatus* group members; while among those species having a single-pointed egg tooth there occur two members of the *auriculatus* group (*martinicensis* and *urichi*).

Schwartz (1969) regarded *Eleutherodactylus jamaicensis* as a possible member of the *auriculatus* group, although this group is not otherwise known to occur in Jamaica except through introduction. Crombie (1977), on the other hand, elected to place *jamaicensis* in a distinct, mono-typic species group (the *jamaicensis* group) in spite of its apparent similarity to members of the *auriculatus* group as noted by Schwartz.

While it is possible to explain away the bifurcate egg tooth of *Eleutherodactylus jamaicensis* on the basis of the close similarity of this species to members of the *auriculatus* group, there is no simple explanation, hypothetical or otherwise, for the occurrence of the bifurcate egg tooth in *E. grabhami* of Jamaica, *E. decoratus* of Mexico, and *Eleutherodactylus* sp. of Ecuador, other than to accept the quite obvious fact that the bifurcate egg tooth is not exclusively limited to members of the *auriculatus* species group.

The occurrence of the bifurcate egg tooth in an apparently wide diversity of non-*auriculatus* group species will remain problematic until a considerable amount of new data is available. The occurrence of a single-pointed egg tooth in *martinicensis* and *urichi* (both *auriculatus* members) is, on the other hand, more interesting than problematic.

Research currently underway suggests that, in certain respects, *Eleutherodactylus martinicensis* is closely related to *E. johnstonei*, *E. pinchoni*, and *E. barlagnei*. These four species, all of which occur in the southeastern Caribbean, may, in fact, form a discrete subgroup within the genus. *Eleutherodactylus johnstonei* probably originated in the southeastern Caribbean, but has since been widely introduced on various Caribbean islands, and in northern South America (Hardy and Harris, 1979). The three remaining members of this group occur only on the islands of Guadeloupe (*martinicensis*, *pinchoni* and *barlagnei*), Antigua, Dominica, Martinique, and several small islands in the vicinity of Guadeloupe (*martinicensis*). With the exception of *E. urichi* (as presently characterized), *E. martinicensis* may, in fact, reach the southernmost latitudes of any assumed member of the *auriculatus* group. Another frog, erroneously attributed to *Eleutherodactylus urichi* by Barbour (1914, 1930), occurs south of Martinique on the islands of St. Vincent and Grenada. The possible relationship of this frog to the *auriculatus* species group, and the nature of its egg tooth, are, unfortunately, unknown pieces in an increasingly fascinating puzzle.

Lynch (1976) described an assemblage of primarily South American (mainland) species of *Eleutherodactylus* which he called the *unistrigatus* group, but pointed out that this group "may not prove separable from the Antillean *auriculatus* group." These two groups were separated on the basis of the fact that, in the *auriculatus* group, the frontoparietal bone is always fused to the prootic, and the median ramus of the pterogoid never overlaps the parasphenoid ala; whereas, in the *unistrigatus* group, the frontoparietal bone is rarely fused to the

prootic, and the median ramus of the pterogoid *usually* overlaps the parasphenoid ala. Although Schwartz (1967) clearly regarded *E. urichi* as a member of the *auriculatus* group, Lynch (1976), in the absence of available skeletal preparations, listed it only as a putative member of the group.

I have examined a single, recently-stained skeleton of *Eleutherodactylus urichi*. In this specimen the frontoparietal bone is fused to the prootic, and the median ramus of the pterogoid appears not to overlap the parasphenoid ala. On this basis *E. urichi* clearly fits Lynch's definition of the *auriculatus* group. On biogeographical grounds, however, the occurrence of a member of a typically West Indian species group member on the islands of Trinidad and Tobago is odd. Lack (1976), working with birds, postulated a faunal barrier between the islands of Grenada and Tobago which he called "Bond's line". This "line" varies in effectiveness from group to group. It is least effective in limiting the distribution of South American (continental) species northward, and most effective in limiting the distribution of West Indian species (or species groups) southward. *Eleutherodactylus urichi* is consequently unique in being the only representative of a strictly West Indian anuran species group to have crossed "Bond's line". The problem of *E. urichi* is further complicated by the fact that it appears to be endemic to the islands of Trinidad and Tobago, and does not reach the South American mainland as has previously been supposed (Hardy, 1970, 1982).

To briefly review, the bifurcate egg tooth has been observed in a number of species of *Eleutherodactylus* representing several different sub-groups within the genus. It seems to occur with significant frequency in members of the West Indian *auriculatus* group. In thirteen of the fifteen members of this group for which the egg tooth is known, the egg tooth is bifurcate. It is perhaps significant that the two exceptions (*martinicensis* and *urichi*) occur at or near the southern limits of the assumed range of the *auriculatus* group (Figure 5).

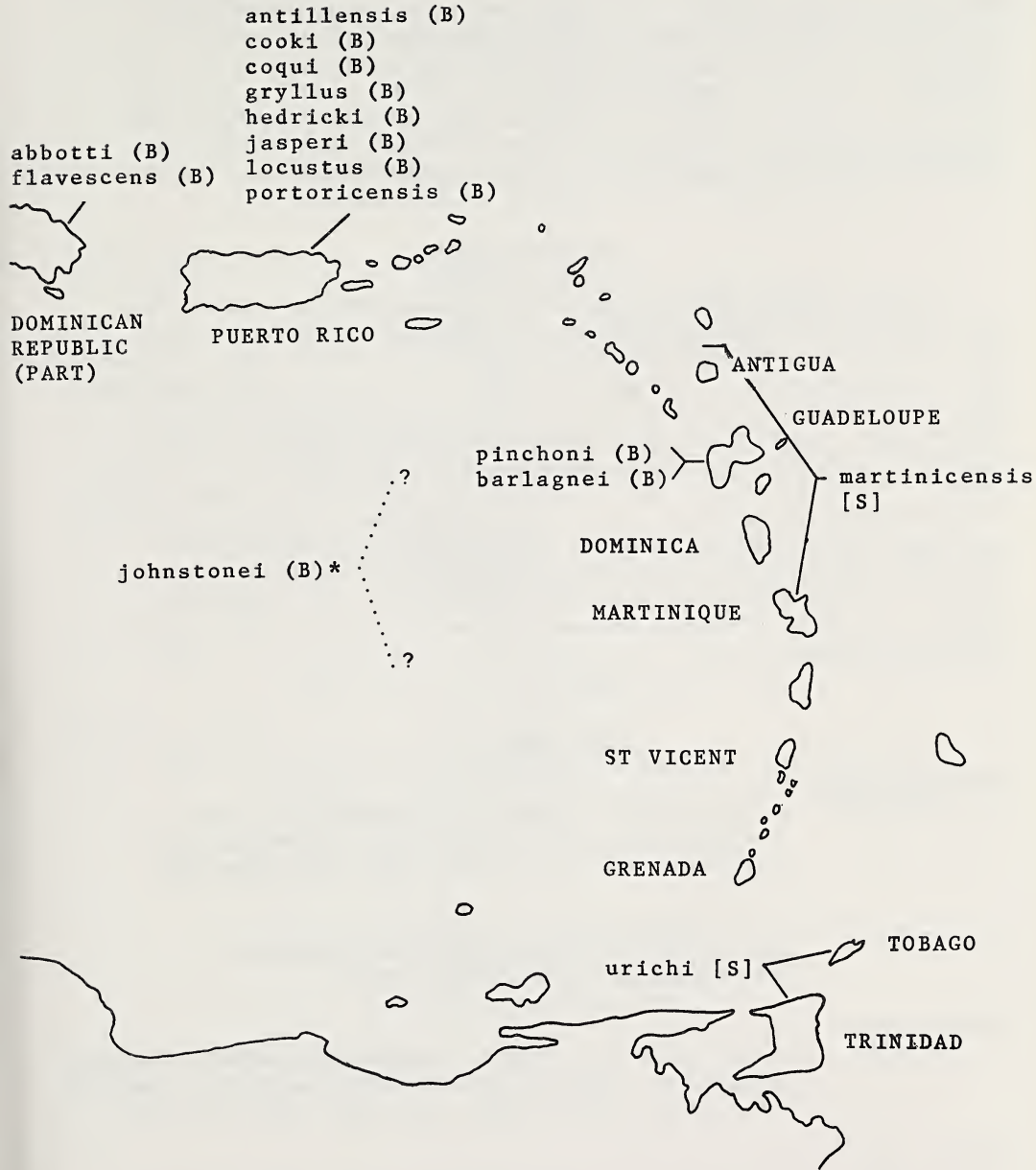


Figure 5. Distribution of *Eleutherodactylus auriculatus* group members for which the egg tooth is known. The symbol [B] indicates a bifurcate egg tooth, [S] a single-pointed egg tooth. The frog from St. Vincent and Grenada is excluded, since its egg tooth and relationship to the *auriculatus* group is unknown. *The place of origin of *Eleutherodactylus johnstonei* is unknown, although it presumably originated in the southeastern Caribbean. Its range now extends through multiple introductions, west to Jamaica, Curacao, and Caracas, Venezuela; south to Georgetown, Guyana, and north to Bermuda.

It is, of course, impossible to draw meaningful conclusions based on the examination of the egg teeth of only 36 members of a group as large as the genus *Eleutherodactylus*. Future work on this project will require, in fact, not only large numbers of additional specimens, but also, perhaps, answers to certain specific questions (implicit in Noble's earlier comments) involving the nature of the chorion, the micro-climate of the nest sites, and the presence or absence of parental guardianship of the eggs in individual species.

Acknowledgements

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HERPETOLOGY OF TOBAGO:
ADDITIONS, DELETIONS, AND TAXONOMIC CHANGES

Jerry D. Hardy, Jr.

Abstract

Several changes have been made in the list of amphibians and reptiles of Tobago, West Indies, as presented in 1982 (Hardy, 1982). In addition, three interesting but highly questionable new records have been discovered. These changes and/or records are as follows:
Deletions - *Gonatodes humeralis*, *Clelia clelia clelia*. New records - *Hyla minuta*. Questionable records - *Rana palmipes*, *Kentropyx striatus*, *Gonatodes albogularis*. Taxonomic changes - *Leptodactylus* cf *pentadactylus* to *Leptodactylus* sp., *Colostethus* cf *dunni* to *Colostethus olmonae*.

In 1982 I reviewed the herpetology of the West Indian island of Tobago (Figure 1).



Figure 1. Map of the southeastern Caribbean showing the position of Tobago.

Since that time one additional species has been collected on the island; records of three other species (all questionable) have been discovered; and two significant taxonomic changes, one based on an error, and one on a recent type description, have been made. In addition, sufficient information has now been gathered to justify deleting two species from the island's fauna.

Deletions

Gonatodes humeralis (Guichenot)

A number of authors (Wermuth, 1965; Peters and Donoso-Barros, 1970; Maclean, et al., 1977; Hardy, 1982) included Tobago in the range of this species, but presented no substantiating evidence of its occurrence there. Mertens (1972), in his synopsis of *Gonatodes humeralis*, listed, along with two of the papers cited above, "Underwood 1962:57,168 (zwischen Speyside und Charlotteville)". He was obviously unaware of any additional records from Tobago, and did not collect the species himself during his visit to the island. Underwood (1962) first recorded *Gonatodes humeralis* from Tobago, commenting that "this little gecko has been taken only once, near the road between Speyside and Charlotteville". All of the material collected by Dr. Underwood in Tobago was deposited in the collection of the Museum of Comparative Zoology (Underwood, personal communication). There are, in the MCZ, five specimens of *Gonatodes* collected by Underwood in 1938, three of which (MCZ 55768-70) were taken, collectively, along or near the road between Speyside and Charlotteville. These five specimens were originally catalogued as "*Gonatodes* sp.", but were subsequently identified as *Gonatodes ocellatus* (a species which Underwood did not include in his list of Tobago lizards). I have found no specimens of *Gonatodes humeralis* from Tobago in any of the American, European, or Trinidadian collections which I have queried. It seems evident, therefore, that the only record of "*Gonatodes humeralis*" from Tobago is based, in fact, on *Gonatodes ocellatus*, and that the continued inclusion of *Gonatodes humeralis* in the Tobago herpetofauna is unjustified.

Gonatodes humeralis is otherwise known from the island of Trinidad, and on the South American mainland from Venezuela and Colombia south to Brazil and Bolivia (Peters and Donoso-Barros, 1970). *Gonatodes ocellatus* is apparently endemic to Tobago (Boos, 1977; Hardy, 1982).

Clelia clelia clelia (Daudin)

In 1982, I included this species in the herpetofauna of Tobago "with considerable doubt" (Hardy, 1982), and pointed out the Barbour's original record of *Clelia* from the island (Barbour, 1916) was based, in fact, on five specimens of *Pseudoboa newwiedii*. These specimens were collected in 1916 by H. L. Clark and W. E. Broadway. Labels in the various jars show an interesting history of the taxonomic interpretation of these specimens from *Clelia clelia* (Daudin)" to *Pseudoboa clelia* (Daudin)" to, finally, *Pseudoboa newwiedii*". Final determinations (as *P. newwiedii*) were made by "Dunn" (E. R. Dunn) and "J.R.B." (Joseph R. Bailey). I have found no specimens of *Clelia clelia* from Tobago in the various American, European, and Trinidadian collections which I have queried; and therefore recommend that this species be deleted from the herpetofauna of Tobago.

It may seem odd that this wide-ranging Central and South American species is found on Trinidad and on the Caribbean islands of Grenada, St. Lucia, and Dominica (Peters and Oregas-Miranda, 1970; Schwartz and Thomas, 1975; Maclean, et al., 1977), but not on Tobago. Similarly fragmented ranges of certain South American genera and/or species to various, sometimes widely separated, offshore islands, is, however, a striking biogeographical feature of the entire southeastern Caribbean.

New Records*Hyla minuta* Peters

This frog has recently been collected or observed at a number of localities in Tobago. Specimens are now being catalogued in the collections of the United States National Museum of Natural History and The British Museum of Natural History. Complete documentation of this interesting new record will be presented in a subsequent paper (Read and Hardy, manuscript in preparation).

Questionable Records*Rana palmipes* Spix

Krintler (1982), in summarizing his observations on the herpetofauna of Tobago, commented that "Eine andere Froschart, die wir am Doctor-River fanden, war *Rana palmipes*, ein 10 cm vorwiegend aquatisch lebender Frosch; ..." Unfortunately, no specimens were secured (Karsten Krintler, personal communication), and I consequently regard this sight record as possible, but extremely doubtful. *Rana palmipes* otherwise occurs from Central America to Peru and Brazil and on the island of Trinidad (Rivero, 1961). It is regarded as rare in Trinidad (Kenny, 1969).

Kentropyx striatus (Daudin)

Gallagher (1979) listed a number of specimens of this species from Trinidad, and a single specimen (ANSP 9811) from Tobago. This specimen, which is clearly *Kentropyx*, was donated to the Academy of Natural Sciences of Philadelphia by Dr. Benjamin Sharp, a physician and zoologist who was associated with the Academy during the later part of the nineteenth century. He made collections of minerals, plants, mollusks, reptiles, and mammals in "The Windward Islands" and/or "The Caribbees" during the winter of 1888-1889. Although I have been unable to locate a specific itinerary of Dr. Sharp's Caribbean trip, I have been able to establish, through the series of papers entitled "Additions to the Museum" (Academy of Natural Sciences of Philadelphia, 1891, 1892, 1893, 1894, 1897) that he visited at least the islands of Trinidad, Tobago, Dominica, and Antigua.

Unless other specimens of *Kentropyx* are obtained from the island, it may never be possible to determine whether Sharp's specimen actually came from Tobago. The series of "Additions to the Museum" (cited above) clearly shows, however, that Sharp accurately distinguished between collections of mollusks and mammals made on the two islands of Trinidad and Tobago. This accuracy is also evident in the catalogue book of the Academy's reptile collection which includes, among other things, records made by Sharp of individual specimens of *Polychrus marmoratus* from both islands. *Kentropyx striatus* has a uniquely limited range in Trinidad, where it is characteristically found only in savanna areas having low vegetation (Boos and Quesnel, 1971). Although such areas are now uncommon on Tobago, this may not have always been so. A considerable amount of swamp and marsh habitat has been destroyed on the island in the last hundred years (West India Committee, 1920; Gillette, 1948, 1953; Niddrie, 1961).

Gonatodes albogularis (Dumeril and Bibron)

Academy of Natural Science of Philadelphia (1897) lists, among its herpetological acquisitions for 1896, "Benjamin Sharp, *Gonatodes albogularis*, from Tobago". There are, at present, no specimens of *Gonatodes* of any species from Tobago in the Academy's collection, and this record is consequently highly questionable. *Gonatodes albogularis* occurs in Central and South America, as well as on Cuba (possibly by introduction), Grand Cayman, and Jamaica, and in Haiti and the Dominican Republic. It is not known from Trinidad or any of the islands of the southeastern Caribbean. It is perhaps worth pointing out that most of Sharp's Caribbean material was listed among the "Additions to the Museum" between the years 1891 and 1894, while the record of *Gonatodes albogularis* was not noted until three years later (ANSP, 1897). This implied passage of time may account for some unknown error in the trans-

posing of locality data. Although the specimen in question almost certainly did not come from Tobago, it would be interesting to know if Sharp visited any island on which he might have collected it (assuming that the original identity was correct).

Taxonomic Changes

Leptodactylus sp.

In 1982 I suggested, on the basis of highly speculative information, that *Leptodactylus* cf *pentadactylus* may have occurred on Tobago within recent historic times. If such a frog existed, and if it was con-specific with either of the two large species of *Leptodactylus* now known to occur on Trinidad, it could have been either *Leptodactylus bolivianus* (Boulenger) or *Leptodactylus macrosternum* (Miranda Ribeiro). *Leptodactylus pentadactylus* does not occur in Tobago (Kenny, 1969, 1977). It is perhaps best to regard the unknown Tobago frog as *Leptodactylus* sp.

Colostethus olmonae Hardy

The *Colostethus* of Tobago, formerly referred to as *Colostethus* cf *dunni*, has recently been described as a distinct, endemic species (*Colostethus olmonae* Hardy, 1983). In spite of this, its relationship to *Colostethus dunni* of Venezuela, to which it is strikingly similar, remains problematic.

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THE NEW SCIENCE OF ESAGOGICS

The literature on various aspects of the introduction by man of exotic plants and animals into native biota in different places all over the world has begun to burgeon impressively, reflecting improved avenues and frequency of interchange and progress in analysis of economic values - direct and indirect - of previously unappreciated species. Introductions have been both deliberate and inadvertent, and as they increase in frequency of occurrence they increase problems of ecological stability that are of growing magnitude and concern. The masterful analysis of herpetological introductions and their impact in Florida by Wilson and Porras (1983), and the perceptive treatise on the evolutionary significance of Marine toad introductions by Eastel (1981), are two examples among hundreds of articles that might be cited in herpetology alone.

In brief, the study of biotic introductions and their impact has become a discipline of its own, largely ecological in nature, that deserves its own name, here proposed as "esagogics."

The Latin word "introduction" does not lend itself readily to any combining form meaning the "study of" or "science of" or "knowledge of," hence one must turn to Greek for possible combining forms. The Latin word "introduction" can serve as a point of departure, however; it consists of two parts: "intro," meaning "within," and "duction," from "ductus," meaning "to lead." The Greek equivalents are "eso" and "ago," respectively, the latter taking the form of "agogos" for "leading," as exemplified by the derived English words of pedagogue (teacher), demagogue (a charismatic leader), and synagogue (an assembly of worshippers).

Combining the Greek equivalents of the Latin word "introduction," in a manner made familiar by the English words cited, produces "esagogue" for any introduced species, "esagogy" for the practice of introduction, "esagogic" to mean of or pertaining to an esagogue or esagogy, and "esagogics" (construed as singular in number) meaning the study or science or art or knowledge of esagogy, the practice of introduction of plants or animals into areas where they are not native. The suffix "-ics," derived from the Greek "ika," is now used to denote "the body of matters, facts, knowledge, principles, etc., pertaining to a subject," such as physics, politics, ethics, tactics, etc.

As man inevitably continues to manipulate his environment, esagogics can only increase in importance, certainly to the point where general texts will be written and college courses offered in the subject.

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LONGEVITY RECORDS FOR LIZARDS
OF THE FAMILY HELODERMATIDAE

Previously published records of *Heloderma horridum* and *H. suspectum* have shown that the average specimen lives approximately 20-25 years (Nigrelli 1954; Bogert and Martín Del Campo 1956; Crosman 1956; Taub 1963). Bowler (1977) was the first person to present data indicating that the life span of these lizards was actually longer than 25 years and also summarized age records for most subspecies. The following table represents current longevity records for all the known subspecies of *Heloderma* as of July 1, 1983 (Table 1).

TABLE 1
HELODERMATID LONGEVITY RECORDS
AS BASED ON SPECIMENS HELD IN CAPTIVITY

Species	Sex	Time Spent In Captivity (Years/Months/Days)			Presumed, Total Age (Years)	
<i>Heloderma horridum horridum</i> ^{2,3}	F	28	0	--	31+	Sacramento Zoo, California, USA
<i>Heloderma horridum alvarezi</i> ^{2,3}	M	33	1	11	38+	Instituto de Historia Natural, Tuxtla Gutierrez, Chiapas, Mexico
<i>Heloderma horridum exasperatum</i> ²	F	15	3	--	18+	Atlanta Zoological Park, Georgia, USA
<i>Heloderma suspectum suspectum</i>	M	18	9	18	21	Santa Paula Union High School, Santa Paula, California, USA
<i>Heloderma suspectum cinotum</i> ²	F	14	10	--	18+	Atlanta Zoological Park, Georgia, USA

¹Computed by adding the estimated age at capture (as extrapolated from length-age data presented by Bogert and Martín Del Campo (1956)) with time spent in captivity.

²Still alive as of 8/1/83.

³Listed in Bowler (1977).

As can be observed from this information, the upper age limit for Helodermatid lizards now appears to be about 40 years; a life span comparable with those exhibited by many species of snakes (Goin, Goin, and Zug, 1978). Both of the older *Heloderma horridum* specimens listed are showing advanced signs of age, especially the 38+ year old *H. h. alvarezi* which has a cataract in one eye. Although it cannot be ascertained with complete certainty, discussions with many long time *Heloderma* owners indicate that lizards fed on a mixed diet of live food (i.e., stunned baby chicks, mice, etc.) live longer than those receiving a strict diet of chicken eggs.

I would like to thank the following people for their help and cooperation in obtaining the information used in this note: Miguel Alvarez Del Toro, Robert Cooper, William DeJesus, Jim Glenn, Dennis W. Herman, R. Howard Hunt, Howard E. Lawler, Thomas J. Moisi, John J. Richards, Glenn R. Stewart, and Yvonne Ruiz.

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NEWS AND NOTES:

NEW YORK ZOOLOGICAL SOCIETYTURTLE TAGGING AT TORTUGUERO

For the serious field person, the New York Zoological Society (NYZS) is offering an opportunity to work on the renowned turtle beach of Tortuguero in Costa Rica. The new program is designed to support and augment sea turtle research sponsored by the Caribbean Conservation Corporation (CCC). The NYZS will assemble four teams of hearty people to work during the July-September turtle nesting season in 1984. The team will be escorted by a NYZS staff person and will be supervised by a core staff of CCC personnel.

Green turtle research at Tortuguero, now in its 28th year, is directed by Professor Archie Carr of the University of Florida. The breeding colony using the beach is the largest in the Caribbean. The beach is protected by the 19,000 hectare Tortuguero National Park, and Dr. Carr's research on sea turtles there has led to a world-wide awakening to the biological mysteries and conservation needs of these endangered reptiles.

The NYZS initiative, with your participation, will measurably bolster the field studies at Tortuguero, and will reward you with a rare, if rigorous, tropical experience. Good food and housing are assured at the CCC Green Turtle Station. The work, however, is tough, with miles of nighttime beach walking, tagging sea turtles often in heavy wet season rain. You need a strong back and a good will. But if exposure to sea turtles and to fine tropical rainforests and wildlife appeals to you, please join us.

Departures from Miami are tentatively scheduled for July 13, July 27, August 10 and August 24. Each tour will be of 18 days duration and will include 14 days at Tortuguero, plus 4 days in transit.

Optional touring of the great parks of Costa Rica prior to or after your Tortuguero field work can be arranged.

We hope you will sign up and help us help the turtles.

CONTACT: John Behler, Curator of Herpetology
New York Zoological Society
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Published by the author, 1983. 254 pp., \$25.00 (\$20.00 paper-bound) plus \$1.50 postage, (\$2.50 overseas).

This inventory is an ongoing project with corrections, updates, and expansions being planned over the next several years. All institutions, worldwide, holding live reptiles and/or amphibians are asked to submit inventories and breeding information current up to January 1st of each year. Private collectors are also welcomed to submit information, but emphasis is on those collections which have breeding potential, have had breeding success in the past, or hold species which are rare or difficult to obtain. I hope to compare annual inventory data, as well as producing the inventory and breeding information.

I am now preparing to receive information current as of January 1, 1984. If you keep live reptiles and/or amphibians in captivity, please respond with the information requested below.

- (1) A complete inventory of all reptiles and amphibians held in your collection current as of January 1st. Sexes should be included and can be listed "male/female/unknown sex."
- (2) A list of all species which bred and produced young during 1983, including numbers of young for each species.
- (3) Any miscellaneous breeding information (use the information presented in the 1983 edition as a guide). Include detailed information for all species which you feel should be listed.

NEW BOOK NEWS:

- (4) A listing of any publications, including books, museum bulletins, journals, magazines, etc., with reference to reproduction in reptiles and amphibians. References pertaining to the care of individual species as well as more general articles relating to temperature, light cycle, hibernation, etc., are of interest.

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THE LIZARD PARIETAL EYE: A ROLE IN THERMOREGULATION

Kristin Lopez

Abstract

The parietal eye, a parapineal functional photoreceptor found in fifty-nine percent of lizard genera, appears to be involved in behavioral thermoregulation. Its occurrence is positively correlated with habitat/latitude. Removal or shielding of the eye results in increased exposure to bright sunlight and higher ambient and body temperature selection. It may function as a dosimeter of light, thus providing an estimate of the radiant heat available for thermoregulation. Excessive stimulation of the parietal eye appears to lead to behaviors limiting photothermal exposure, thus preventing overacceleration of metabolic processes.

Lizards, like other ectotherms, are dependent on the environment for their source of heat. However, in general they do not passively assume a body temperature equal to that of their surroundings. In fact, their body temperature is very often different from the ambient temperature. This ability to take an active role in controlling body temperature, thermoregulation, is important in maintaining homeostasis.

Metabolism is highly influenced by body temperature - each 10°C increase approximately doubles metabolic rate - and many physiological processes including growth and reproduction are temperature-dependent. Most lizards have a "preferred temperature" or range of temperatures which they will maintain within certain environmental limits; in general, physiological processes are optimally maintained at each species' preferred temperature.

Most reptilian thermoregulation is accomplished by species-specific behaviors. Thermoregulators can be divided into two major groups, differing by the method used to obtain environmental heat. Thigmotherms conduct heat from the substrate. They are burrowing, aquatic or nocturnal forms which avoid temperature extremes and, particularly, have little contact with direct sunlight. Heliotherms gain radiant heat from basking in the sun. They maintain their preferred temperature by selecting a particular micro-habitat (a sunny rock, sand or shade), depending on heat requirement, and by posturing or orienting with respect to the sun's position. When the ambient temperature drops too low to allow thermoregulation, heliotherms will burrow underground.

Control of thermoregulation involves the hypothalamus and, in some species, the pineal (epiphyseal) complex. This discussion reviews evidence for an epiphyseal role in lizard behavioral thermoregulation.

The pineal develops as an evagination of the roof of the brain in the diencephalon. In the adult, it is attached by a stalk to the brain roof. The pineal is found throughout vertebrates, from cyclostomes to mammals, although it is absent in some groups. It tends to be more complex in lower vertebrates. In most ectotherms, it is composed of two distinct structures - an epiphysis cerebri or pineal proper inside the cranium, and an extracranial parapineal component.

Epiphyseal morphology is variable; the pineals of lower vertebrates may contain mostly photoreceptive cells, whereas more advanced forms tend to have glandular pineals. Most lizards have glandular pineals secreting various peptides and indoles, including melatonin.

Approximately 59% of lizard genera possess a well-developed parapineal structure, the parietal or "third" eye. It is located in a foramen (small hole) between the parietal bones of the skull. In most species it can be seen by the unaided eye as a small light-colored spot, about 0.2 millimeters in diameter, on the middle of the skull posterior to the lateral eyes. Dissection reveals that it is composed of a cornea, lens, retina and fluid-filled cavity. Thus the organization of the third eye is similar to that of the lateral eyes, except that it is not involuted and does not include ocular muscles or an eyelid. The retina contains sensory receptor cells which have some rod-like and some cone-like characteristics (Eakin, 1973). The parietal eye responds to the presence of light and can discriminate wavelength. Retinal photoreceptive cells send messages to the pineal body and other parts of the brain via the parietal nerve.

Students of the epiphyseal complex have offered several theories of parietal eye function. Some have considered it merely a vestige of an image-forming eye. Other theories include modulation of circadian or seasonal rhythmicity, inhibition of sexual function, production of Vitamin D, thermoreception, and photoreception; it was once suggested that the third eye was a lookout for the devil! A large body of evidence supports the role of the parietal eye as photoreceptor, sending information to the pineal to influence rhythmicity and reproduction (for review see Ralph et al., 1979). This report focuses on evidence that the parietal eye is used by lizards to sense thermal information from the environment.

The ability to thermoregulate is most advantageous in environments with wide temperature fluctuations. Thus, equatorial species are not as likely to rely on thermoregulation as are those species living at higher latitudes. If the parietal eye functions in thermoregulation, one would expect to find it most frequently in high latitude groups. Indeed, this appears to be the case. Gundy and coworkers (1975) examined the rela-

tionship between occurrence of parietal eyes and center of abundance of four large successful families of lizards. He found that teiids and geckos, both of which lack parietal eyes in nearly all species, are most abundant within 10° of the equator. In two other families, Iguanidae and Agamidae, most genera have parietal eyes. Both of these families are centered between 20° and 30° north or south of the equator. Furthermore, the single iguanid genus which lacks a parietal eye and all five parietal eyeless agamid genera are centered on the equator. Thus there is a distinct geographical correlation with presence of a parietal eye in these four major families. This correlation indicates that the parietal eye may be important in environmental adaptations at high latitudes involving thermoregulation, reproductive timing, or some other aspect of rhythmicity cued by light or temperature fluctuations.

In order for the parietal eye to affect behavioral thermoregulation, its presence must, first, alter the lizard's exposure behavior and, secondly, the difference in exposure must be effective in changing the animal's body temperature. A number of experiments have investigated the effect of removing or shielding the parietal eye on thermal exposure and body temperature.

The first major finding on the effect of the parietal eye on exposure was reported by Stebbins and Eakin in 1958. They performed a field experiment with 373 free-living *Sceloporus occidentalis* (western fence lizard). Half of the animals were parietalectomized (parietal eye surgically removed) and half sham-operated. During a two-week period, sixty-three observations were made of the study area. The numbers of parietalectomized and sham-operated lizards exposed to sunlight were counted, and time of day noted. The total ratio of exposed experimental to exposed control animals was greater than 4:3, a highly significant deviation from the 1:1 expected ratio. Both groups basked with equal frequency at mid-day, but parietalectomized lizards appeared earlier and retired later than the control group, thus extending their daily exposure time. There was, however, no significant difference in cloacal temperature between the two groups in this study.

Subsequent studies lent support to the idea that the parietal eye affects basking behavior. In a laboratory setting, Stebbins and Wilhoft (1966) studied the effect of parietal eye shielding (by aluminum paint) on *Sceloporus virgatus* (striped plateau lizard). They observed increased exposure of the eye-shielded group in the brightly lit portion of their cage. Packard and Packard (1972) found increased exposure to bright sunlight of parietal eye-shielded male, but not female *Callisaurus draconoides* (zebra-tailed lizard). Parietalectomized *Xantusia vigilis* (desert night lizards) spent more time in bright sunlight than did controls (Stebbins, 1970). Although other experiments reported similar results, in no case did lizards with shielded or ablated parietal eyes demonstrate less exposure to sunlight than control groups. Thus it appears that the parietal eye is effective in limiting exposure to bright light.

Further investigations revealed that the difference in exposure of parietectomized and sham-operated lizards resulted in a difference in body temperature. Roth and Ralph (1976) found that a parietectomized group of *Anolis carolinensis* (American chameleon) had significantly higher body temperatures than did sham-operated controls. A similar finding was obtained with *Sceloporus magister* (desert spiny lizard) (Engbretson and Hutchinson, 1976).

Out of these experiments emerged a theory that the parietal eye functions as a dosimeter of solar radiation. The basic arguments for the theory are as follows. Most temperate lizards have daily and seasonal cycles of activity, and seasonal reproductive cycles which are critical to their survival. These rhythms are dependent on the environmental parameters of heat and light in two important ways. Light and/or heat may be cues for the onset of physiological changes involved in rhythmicity. Temperature can alter metabolism and affect the rate of processes such as gonadal growth, which can accelerate or decelerate seasonal cyclic phenomena. Thus, exposure to heat and light must be narrowly controlled for species in which they influence the timing of seasonal events. Exposure must also be limited in lizards whose preferred temperature is near the lethal limit.

It is believed that the parietal eye gauges the amount of light, and the consequent radiant heat, in the environment. This information is conveyed to the pineal and other parts of the brain, which initiate behaviors regulating exposure. Specifically, excessive stimulation of the parietal eye results in decreased photothermal exposure. This prevents overacceleration of metabolic processes on unseasonably warm, bright days.

To fully understand the role of the parietal eye in behavioral thermoregulation, it is critical to know if it uses photic information as an estimator of heat content in the environment, or if it is a direct thermal receptor. Two lines of experimentation have attempted to separate the effects of heat and light - physiological responses of the parietal eye to the stimuli, and behavioral responses of the organism.

A number of studies have shown conclusively that the parietal eye is sensitive to light. Electrical recordings (electroretinograms) from the retina of the third eye show characteristic activity upon illumination (Dodt and Scherer, 1968). The response changes when the eye is presented with a different wavelength; the parietal eye is color-sensitive. No such evidence exists to support a direct thermoreceptive role. The eye has a very low sensitivity to infrared light (Hamasaki, 1969). Furthermore, it contains no pigment granules, which presumably are required for heat absorption.

Behavioral studies appear to contradict the idea that the parietal eye is exclusively a dosimeter of light. Hutchinson and Kosh (1974) first demonstrated a direct role in thermal selection. They placed adult

Anolis carolinensis in a chamber with a thermal gradient, with heat supplied from the floor, and under constant cool illumination. The animals were divided into parietalectomized and sham-operated groups. Temperature selection and body temperature were recorded. At all times of the day and night except for the period from 8:00 a.m. until noon, parietalectomized animals showed a significantly higher temperature selection, with accompanying higher body temperature, than the control group. A similar experiment using *Sceloporus magister* (Engbretson and Hutchinson, 1976) supported the idea of a direct thermoreceptor role of the parietal eye; parietalectomized *S. magister* also chose significantly higher body temperatures than controls on a thermal gradient when light was held constant.

To determine the relative importance of heat and light stimuli to the parietal eye, Roth and Ralph (1977) presented parietalectomized and sham-operated *Anolis carolinensis* with choices of light or heat stimuli, presented singly or in a combination photothermal gradient. Parietalectomy increased exposure of the lizards to both heat and light stimuli. However, the increase in thermophilic behavior was greater than that of photophilic behavior.

Parietalectomized lizards select higher temperatures than controls under constant lighting conditions. Parietalectomy increases thermal exposure more than it increases photic exposure. The theory of the parietal eye as a light dosimeter does not explain these findings. The eye may contain thermoreceptors; the lack of physiological or anatomical evidence does not disprove their existence. However, the parietal eye could serve another function in thermoregulation. It may act in some manner to set the hypothalamic thermostat, limiting its setpoint. Destruction of the parietal eye would then raise the setpoint, causing the animal to attempt to maintain a higher temperature.

The parietal eye has been convincingly shown to have an effect on temperature selection in lizards. The eye uses light information as an estimator of environmental heat, and probably can also sense thermal stimuli directly. The function of the eye appears to be to limit heat-seeking behaviors. This prevents lethal overheating of the animal, and unseasonal growth of organs involved in cyclic activities. Parietalectomy has been shown to increase thyroid and gonadal activity in *Sceloporus occidentalis* (Stebbins and Cohen, 1973). The adaptive significance of the structure has not been fully investigated, however. No studies have looked at longevity or reproductive output in parietalectomized lizards. The effect of the parietal eye on the pineal and on the hypothalamus is not clear. The question of thermoreceptor function still remains. The role of the parietal eye in thigmotherms needs clarification. These and other investigations could aid in further understanding this sensitive structure once thought to be degenerate.

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DISTRIBUTIONAL RECORDS FOR MARYLAND HERPETOFAUNA, III

The specimens mentioned below are deposited in the following collections: Academy of Natural Sciences of Philadelphia (ANSP), Carnegie Museum of Natural History (CM), Natural History Society of Maryland (NHSM), Richard T. Highton (RTH) (housed at the University of Maryland, College Park, Maryland), Towson State University (TSU), U.S. Biological Survey (USBS) (housed at the Patuxent Wildlife Research Center, Laurel, Maryland). CM material was verified by CM personnel; RTH specimens were not seen and bear lot numbers. Unsupported distributional statements are based on Harris (1975).

Notophthalmus viridescens (RTH 61-84)

Eastern Shore records for the red-spotted newt are few. This specimen is from 1.75 km NNE Lakesville, Dorchester County, and is the first for the county.

Ambystoma opacum (TSU 5950)

A brooding female was collected by the writer near Bird Hill, Carroll County on 26 September 1983, providing the first locality for the county.

Desmognathus fuscus (RTH 64-353)

Eastern Shore records for the dusky salamander are also few. This specimen is from 1.65 km WSW Matthews and adds a second locality for Talbot County.

Eurycea bislineata (RTH 61-25A [2])

This is another salamander with a spotty Eastern Shore distribution. These two specimens provide a second station for Queen Anne's County. They were collected 2.7 km NW Wye Mills.

Hemidactylium scutatum

The four-toed salamander has been recorded from one locality in both Caroline and Dorchester Counties. Additional sites are provided by RTH 65-478 from 2.4 km E Goldsboro, Caroline County, and RTH 61-84 from 1.75 km NNE Lakesville, Dorchester County.

The species has not been reported from Frederick County. Two brooding females (TSU 5662-5663) were collected near Unionville by the writer on 31 May 1983. The eggs of TSU 5662 were hatching, whereas those of TSU 5663 had not.

In Harford County this species has been plotted from two localities, neither of which appear to be based on preserved specimens or published records. The following stations have been acquired by the writer; all but two individuals were nesting females: Jerusalem, 7 April 1980 (TSU 3455-3456); near Carea, 8 April 1980 (TSU 3466-3468); three localities near Norrisville, 30 March, 21 April, 23 April 1982 (TSU 4685-4687, 4861, 4868); near Kalmia, 22 April 1982 (TSU 4862); near Singer, 18 April 1983 (TSU 5364); near Reckord, 21 April 1983 (TSU 5365-5366); near Houck's Mill, 21 April 1983 (TSU 5368); near Vale, 25 April 1983 (TSU 5384-5385); near Cooper, 17 May 1983 (TSU 5572-5573).

In Howard County the four-toed salamander is known only from Avalon (NHSM/HSR-RSS 26, 127). Fourteen localities, all represented by brooders, were obtained by the writer during 1983: near Dayton, 28 March (TSU 5255); two localities near Mayfield, 1 April (TSU 5248, 5269-5270); near Elioak, 7 April (TSU 5295); near Alpha, 11 April (TSU 5304); Roxbury Mills, 12 April (TSU 5316); Annapolis Rock, 22 April (TSU 5371-5372); near Hipsley's Mill, 26 April (TSU 5386-5387); two localities at Mullinix, 2 May, 4 May (TSU 5444, 5479); near Highland, 9 May (TSU 5509); near West Friendship, 10 May (TSU 5521); near Roxbury Mills, 11 May (TSU 5532-5533); near Watersville, 27 May (TSU 5652-5653).

This species has not been recorded from Queen Anne's County. RTH 61-28A is from 2.2 km NW Starr.

Plethodon glutinosus

The slimy salamander has been reported in Howard County only from Avalon, where it was found in July 1950 by H. W. Campbell, but from which locality no specimens exist (Harris 1966; Campbell, pers. comm.). On 2 May 1983 one individual (TSU 5421) was collected by the writer near Mullinix, and another (TSU 5477) was taken on 4 May 1983 at Mullinix.

Bufo woodhousei (CM 13885-13886)

These valley and ridge specimens are from Black Oak, Allegany County, and are 18 km SW of material reported by Miller (1982), thus making them the westernmost known locality in Maryland and placing them essentially at the base of the Allegheny Plateau. They were collected on 21 July 1937.

Clemmys mühlenbergi (CM 87469)

This specimen was collected in the vicinity of Cecilton, Cecil County on 9 June 1975 and appears to be the only unequivocal coastal plain locality for this turtle in Maryland.

Eretmochelys imbricata

An uncatalogued hawksbill in the collection of the Natural History Society of Maryland bears a label, fashioned for exhibition purposes, stating: "A Marine Reptile Found Occasionally In Chesapeake Bay And The Maryland Coast. It May Reach 3 Feet, And Is Harmless." Hardy's (1972) inaccurate quotation of this label has also led Musick (1972, 1979a, 1979b) and White (1982) to state that the specimen came from the Chesapeake Bay. The provenance of this turtle is unknown.

Eumeces anthracinus (ANSP 9433-9434)

This species is known from Allegany County only from the above specimens, which bear the locality "Allegheny Co., Maryland." Taylor (1935) was the first to publish on these specimens, and several subsequent authors have mentioned or uncritically accepted the record: McClellan

Smith and Smith (1952); Reed (1956); Cooper (1960, 1965); Harris (1969, 1975); Committee ... (1973). Other entries in the ANSP catalogue, however, strongly indicate that these coal skinks were collected in present-day Garrett County. In Maryland *E. anthracinus* is known to definitely occur only in extreme west-central Garrett County, well removed from Allegany County.

Two *Cryptobranchus alleganiensis* (ANSP 537-538; not located) are catalogued "Allegheny Co., Md.," although this salamander does not occur in Allegany County and is restricted in western Maryland to streams in Garrett County that drain to the Ohio River (Fowler 1947; Committee ... 1973; Harris 1975). Two lots of *Notophthalmus viridescens* (ANSP 1613-1626, 4110-4116; 1613-1618 located) bear, respectively, the localities "Oakland, Alleghany Co., Md." and "Oakland, Allegh. Co., Md.," although Oakland is in Garrett County. The *Cryptobranchus* and *E. anthracinus* were apparently collected by the same individual; the collector(s) of the *Notophthalmus* is not recorded.

These seeming contradictions can be explained by considering when the specimens were collected. Although no dates of collection are given in the ANSP catalogue, the above material is among the oldest in the collection and it is probable that it was taken prior to 1872. Before 1872 Garrett County did not exist and the present-day Garrett County was part of Allegany County (Clark 1900, 1902). It should be noted, however, that *Eumeces anthracinus* has been collected in Hampshire County, West Virginia (Smith and Smith 1952), a county that borders Allegany County, Maryland. There is no reason to doubt the validity of this record, which is based on CM 18358 (C. J. McCoy, pers. comm.)

Cemophora coccinea

This snake has not been recorded from Charles County. USBS 10434 was found at the edge of a wheat field adjacent to a marsh along a tidal section of Nanjemoy Creek. It was collected on 1 May 1949. Two other

Eumeces anthracinus (ANSP 9433-9434)

This species is known from Allegany County only from the above specimens, which bear the locality "Allegheny Co., Maryland." Taylor (1935) was the first to publish on these specimens, and several subsequent authors have mentioned or uncritically accepted the record: McClellan et al. (1943); McCauley (1945); Lemay and Marsiglia (1952); Smith and Smith (1952); Reed (1956); Cooper (1960, 1965); Harris (1969, 1975); Committee ... (1973). Other entries in the ANSP catalogue, however, strongly indicate that these coal skinks were collected in present-day Garrett County. In Maryland *E. anthracinus* is known to definitely occur only in extreme west-central Garrett County, well removed from Allegany County.

localities for this rare Maryland species have been recently obtained. TSU 5293 is from Woodland Beach, Anne Arundel County, taken on 12 June 1980, and NHSM 2717 is from Appeal, Calvert County, found dead in a powerline cut on 9 September 1982.

Diadophis punctatus (CM 27022-27023, 31384, 37723, 37851)

Miller (1979) noted the first record for this species in Wicomico County, although older, unreported catalogued material was available at the time. The above specimens are from Quantico and were collected between 1946 and 1961.

Lampropeltis calligaster (USBS 10623)

This species is known from two localities in Howard County (Miller 1982), the northern limit of its range in the eastern United States. The above specimen represents a third locality for Howard County and was taken at 78 Patuxent Drive, near Whiskey Bottom Road, opposite Laurel (Prince George's County), on 26 August 1959.

Regina septemvittata

The queen snake has been reported from three localities in southern Maryland (Hardy and Mansueti 1962; Lee 1973), all in Calvert County. The former authors stated that J. A. Fowler collected the species at Camp Washington. No such locality appears to exist and Fowler has informed the writer that he cannot account for the Hardy-Mansueti statement. Hardy and Mansueti's Camp Boy Haven record from along the Chesapeake Bay is not easily explained and may represent an introduction.

Lee's specimen (NHSM 1799) is from a tributary (probably Cocktown Creek) to the Patuxent River, near "Huntington" (= Huntingtown). This snake is also from a nature camp, but the locality is zoogeographically plausible in that *R. septemvittata* has been taken along and near the Patuxent River well upstream in the piedmont (TSU 5433; two records plotted in Harris 1975) and on the coastal plain near the Fall Line (USBS 9752, 10300, 10368, 10639).

USBS 10596, from 1.0 km S Nottingham, Prince George's County, lends credibility to the Huntingtown station and provides a second reliable locality for southern Maryland. Catalogue data state that it was collected "Hundreds of yards out in tidal marsh of Patuxent River. About 0.5 mile [0.8 km] from nearest high land or fresh stream. First Maryland record for this part of state and for this habitat." The locality is approximately 10 km upstream from the Huntingtown site. It was collected on 18 October 1951.

Storeria occipitomaculata (USBS 9789, 10356, 10357, 10444, 10626)

Following Harris (1975), Miller (1982) claimed to report the first records of this species in Prince George's County. *S. occipitomaculata*, however, was earlier recorded from the Patuxent Research Refuge (now the Patuxent Wildlife Research Center), located between Bowie and Laurel (Anonymous 1957; Patuxent ... 1979). Of the above specimens, the latter four are from the Center and were collected between 1948 and 1962. The first is from the National Agricultural Research Center, on property adjacent the Patuxent Wildlife Research Center, and was taken on 27 September 1942.

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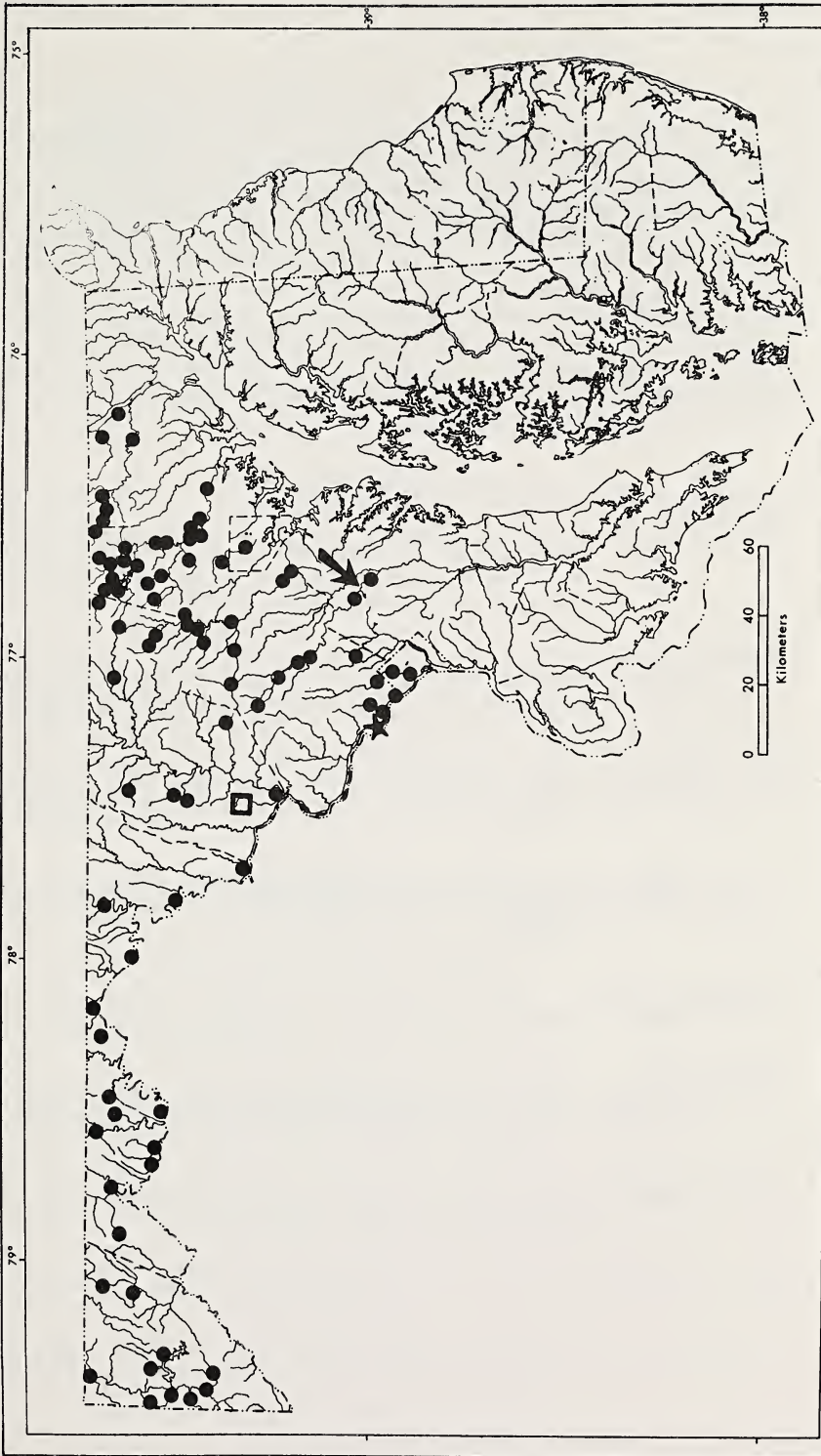
NOTES ON THE DISTRIBUTION OF *Eurycea longicauda* IN MARYLAND

In his distributional surveys of the herpetofauna of Maryland, Harris (1969, 1975) stated that the long-tailed salamander, *Eurycea longicauda*, was absent from the coastal plain. Miller (1979) reported what he believed to be the first record of *E. longicauda* from the coastal plain of Maryland, based on TSU 1860 (5) from Race Road, Anne Arundel County. A subsequent conversation with one of the collectors has shown that the specimens were actually collected on the Howard County portion of Race Road, thus making it moot as to whether this is a truly coastal plain locality.

Apparently the first reported occurrence of the long-tailed salamander on the Maryland coastal plain appeared in a mimeographed list (Anonymous 1957) of the amphibians and reptiles of the Patuxent Research Refuge (= Patuxent Wildlife Research Center), located along the Patuxent River between Bowie and Laurel, Prince George's County. This record was slightly expanded upon in a revised list (Patuxent ... 1979). Specimens supporting the locality are USBS 9747, 9775, 10102, 10343, 10354, taken between 1942 and 1945 by Patuxent personnel. An older but hitherto unreported coastal plain station is UMMZ 65446 (2), from along the Patuxent River, 24 miles (38.4 km) E District of Columbia, Prince George's County, collected on 28 August 1927 by C. L. Hubbs et al. The specimens were taken incidental to a fish collection; additional data in Hubbs' field notes place the collection site 2.5 miles (4.0 km) N Defense Highway (= Md. Route 450). The USBS specimens are approximately 8.0 km (straight-line distance) below the Fall Line, the UMMZ specimens about 17 km.

Figure 1 presents an updated distributional map of *Eurycea longicauda* in Maryland, including the first plotted localities for the District of Columbia. Literature records have not been included. This species is known in Cecil County only from the report of Fowler (1925), who listed it from Conowingo.

Figure 1. Locality records for *Eurycea longicauda* in Maryland and the District of Columbia. Circles represent specimens examined (except RTH); arrow indicates coastal plain records. Square represents only report of *Eurycea guttolineata* in Maryland (plotted by Ireland [1979]); explained by Miller [1980]. Star is possible hybrid (NHSM/HSR-RSS 466) between *E. guttolineata* and *E. longicauda* (Miller 1980).



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Specimens Examined

In addition to the collection abbreviations indicated above, NHSM refers to the Natural History Society of Maryland, TSU to Towson State University.

Allegany County: CM 58734-58735; NHSM 2899-2900, 3205, 4789-4795; TSU 1113-1116, 1313-1314, 1591, 1911, 1918-1919, 1928, 1957-1959, 1968, 5931; UMMZ 97366; USNM 104409-104410, 141315.

Baltimore City: NHSM 3227.

Baltimore County: NHSM 171, 173, 176, 434, 559-561, 562, 725-727, 760, 765, 844, 1201, 1221, 1223, 1534, 1786-1792, 1794-1798, 1975-1977, 2241, 2577, 2578, 2619, 2644, 3225, 3226, 4418-4422, 4535, 4729-4730, 4745, 4787-4788, 4799-4802, 4803, 4811, 4812-4813; NHSM/HSR-RSS 87, 123-124, 153, 155-156, 170, 368, "5032," "5083-5086"; TSU 63, 144-147, 1472, 2160, 2265-2267, 2327-2329, 2408, 2418, 2445-2448, 2452, 2485-2492, 2511, 2788-2790, 2815, 2846, 2927, 3069-3070, 3172-3174, 3243, 3681, 3736, 3761; USNM 144294-144295.

Carroll County: NHSM 4732-4733; TSU 1745 (7), 4091-4093, 4200-4203, 4209-4210, 4227-4230, 4246-4249, 4915-4916, 4991-4996, 5008-5013.

District of Columbia: USNM 75940, 103330.

Frederick County: CM 24837; NHSM 1463, 2660; RTH 58-66, 58-81, 59-86, 59-91; TSU 1112, 3776-3783.

Garrett County: CM 4184, 30656 (9), 58736; NHSM 2051, 3206-3224, 4750, 4798, 4804, 4805, 4807-4808, 4809-4810; TSU 5077; USNM 33653, 101891, 101916-101919, 101920, 102112-102113, 102189.

Harford County: NHSM 1057, 1762; TSU 3008, 3030-3031, 4971-4973, 5582-5583; USNM 144296.

Howard County: NHSM/HSR-RSS 4-5; TSU 1860 (5), 5422, 5476, 5508, 5561-5562, 5626-5637, 5659; USNM 123588.

Montgomery County: NHSM/HSR-RSS 463, 466; TSU 1111, 1117 (17), 5535; USNM 73358, 141316, 141940.

Prince George's County: UMMZ 65446 (2); USBS 9747, 9775, 10102, 10343, 10354.

Washington County: NHSM 3228-3229, 4760, 4797, 4806; NHSM/HSR-RSS 143; RTH 60-93, 65-439, 70-210; USNM 101435, 192388 (2).

—Robert W. Miller, *Museum of Zoology, Towson State University, Towson, Maryland 21204.*

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Accepted: 28 February 1984

RANDOM ROTATION OF *Elaphe* EGGS DURING ARTIFICIAL INCUBATION

On 27 June 1977 a clutch of 16 Yellow Rat Snake (*Elaphe obsoleta quadrivittata*) eggs was laid by a 1 M female as a result of a captive breeding at the Central Florida Zoological Park, Sanford, Florida. The clutch was divided into two groups and set up in two plastic shoe boxes for incubation. The 13 eggs in Group A were individually placed in a crumpled portion of paper towel and marked with a top dead center line to prevent future rotation. The 3 eggs which comprised Group B were distributed on a flat paper towel substrate and were "tumbled" around the container in a random fashion once every two days. Both containers were exposed to the same temperature regime and the eggs were misted with water as needed.

All eggs in both groups proved viable. Following 28 days of incubation one egg from Group B was opened and contained a live embryo that appeared normal. On the 50th day of incubation all eggs in Group A exhibited egg tooth slits and one neonate had emerged. The two remaining eggs in Group B were slit on the 51st day and by this time all Group A neonates had emerged except one. At 1200 hours on the 51st day the last three neonates were manually enticed out of their eggs. All 15 neonates appeared normal. No difference of statistical significance was found between Group A and Group B neonates.

To further test the effects of random rotation of *Elaphe* eggs a pair of Corn Snakes (*Elaphe g. guttata*) was captured in the spring of 1983 in Alachua County, Florida. Breeding occurred during the second day of captivity and a clutch of 17 eggs was laid on 26 June 1983. The eggs were set up in the same manner as previously described with Group A consisting of 7 non-rotated eggs and Group B consisting of 10 eggs which were randomly tumbled one time per day. All eggs were viable and emergence times for the neonates in both groups were as follows: day 65 - Group A (2), Group B (3); day 66 - Group A (2), Group B (2); day 67 - Group A (2), Group B (4). One egg in each group failed to hatch and on the 69th day of incubation these eggs were opened revealing a dead full term embryo in each. No significant difference in neonate mass was found between the two groups and all snakes appeared normal.

Non-random rotation of some reptile eggs has been tested. Marcelini and Davis (1982) rotated *Elaphe guttata*, *Python molurus*, *Eublepharis macularius*, and *Geochelone carbonaria* once a week leaving the same side up or opposite side up. They conclude that "it appears that lizard and snake eggs can be handled without a deleterious effect on hatching success". Feldman (1983) tested rotation of turtle eggs (*Malaclemys t. terrapin*, *Chrysemys p. picta*, *Chelydra s. serpentina*) at specific time intervals and found that "eggs rotated under the stated conditions hatch with about the same success as undisturbed eggs". Drajeske (1974) turned *Chrysemys scripta*, *Chrysemys picta*, and *Terrapene carolina* eggs one to

five times during their incubation period and concluded "that the turning schedule used did not adversely affect the hatching of these eggs". Pawley (1962) also states that "daily rotation of some *Natrix natrix* eggs was not harmful to the developing embryo". In reference to Bullsnake eggs, Kauffeld (1969) writes "I turned these eggs frequently - every other day or two" which did not appear to affect the hatchlings. Barnett (1980) describes manipulation of ruptured python egg (*Liasis childreni*) which included stitching the egg shell to suspend the open egg and to facilitate his observations "the embryo was probed and moved with a sterilized seeker". These manipulations did not adversely effect the developing embryo. Riches (1976) refers to a clutch of *Natrix n. natrix* eggs sent through the mail which "must have been rotated many hundreds of times" and concludes rotation "need not have a deleterious effect".

Egg manipulation, shifting, or rotation can occur in some species under natural conditions. Squamates which are known to brood and or guard their eggs (Fitch 1970, p. 219-220) present opportunity for changes in egg orientation. Oviducal eggs which in some taxa exhibit early stages of embryonic development certainly shift in orientation as a gravid female progresses through a three dimensional environment. Egg rotation in rare cases may also be intentional as Bellairs (1960) notes "The female *Eumeces obsoletus* turns and rolls her eggs daily."

In this study the random "tumbling" of *Elaphe* eggs during incubation presents the most radical departure from the traditional view that turning reptile eggs results in deleterious effects. Unlike the eggs of birds, reptile eggs generally are not rotated in a consistent fashion during incubation. Internal egg anatomy in some taxa may not have evolved far enough to compensate for changes in orientation which could result in stress on internal structures and functions. Bellairs (1970) states the chalazae "appear to be absent in all reptile eggs and it is perhaps because of that disturbance of the eggs during incubation may lead to damage and death of the embryos". This may certainly be true for many reptilian species but differing characteristics within the class represents capabilities in transition which can have the ability to compensate for successive changes in egg orientation.

Acknowledgements

For various courtesies pertaining to the 1977 clutch at Central Florida Zoological Park, I thank T. Bates, E. Posey, and A. Rozon.

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—Frederick B. Antonio, *Santa Fe Community College Teaching Zoo, Gainesville, Florida 32601.*

Received: 22 February 1984

Accepted: 28 February 1984

A SIMPLE METHOD FOR TRANSMITTER ATTACHMENT IN CHELONIANS

Radio-telemetry has been successfully employed for the tracking of reptiles in ecological research. Various techniques for securing transmitter packages (transmitter, battery and antenna) have been used by authors. In designing such a system it is important that the transmitter package is, 1) attached securely, 2) waterproof, 3) able to produce a strong signal, 4) not interfering with normal movements or behavior of the animal, 5) able to allow ease of access for periodic battery change. Ingestion and intraperitoneal placement in snakes (Reinert and Cundall, 1982) and exterior attachment in turtles (Plummer and Shirer, 1975) demonstrate some of the recent techniques found in the literature. In general the technique used reflects the particular body design, habitat and ecological status of the animal under study.

In endangered species of aquatic turtles it is desirable to attach the transmitter package externally without any permanent damage to the carapace (Graham, 1981). Previous papers have described attachment of packages in turtles by making holes in the carapace through which the components are securely attached (Plummer and Shirer, 1975; Shubauer, 1981). Legler, 1979 makes reference to silicon rubber (Silastic) as a means of adhesion.

Following is a reliable method for transmitter package attachment in turtles without permanent damage to the carapace.

A pre-assembled SM 1 transmitter (AVM Instrument Co., 6575 Trinity Ct., Dublin, CA 94566), 1.35 volt Hg battery and antenna (copper or silver stranded wire 0.24 gauge or less) are soldered together to form the transmitter package prior to the external attachment to the carapace of the turtle.

The transmitter and battery are positioned at an angle corresponding to the site of attachment on the turtle's carapace. These two components are then secured to each other by a small amount of epoxy adhesive. This adhesion is designed to strengthen the package while allowing ease of access for later replacement of battery. The components can be easily separated by snapping the epoxy bond. The transmitter itself is coated with a thin, protective layer of epoxy and allowed to dry.

Using the antenna wire as a handle, the package is next immersed into a 1:1 beeswax and paraffin mixture. This procedure is repeated three times or until a sufficient covering is obtained.

After the wax hardens, the package is coated in a layer of clear silicone rubber sealant (Dow Corning Corp., Midland, MI 48640) or some other suitable material to waterseal and prevent physical abrasion to the transmitter (Jansen, 1982). The free end of the antenna is sealed with plastic or epoxy to prevent moisture from entering it.

Attachment of the package is accomplished using the silicone sealant once again. A generous amount is placed on the side of the package. The device is then firmly planted onto the rear edge of the turtle's carapace. It is important that the surface of the shell is clean and dry. If the attachment site is worn smooth, roughing up the surface with sandpaper will improve adhesion.

Silicone sealant is then used to fill in the sharp angles between the carapace and the package to produce an overall fusiform shape. This reduces the shearing stress across the surface thereby insuring package attachment to the turtle. The antenna is secured, with sealant, along the line formed by the marginal and costal scutes (Figure 1).

The above method was used on seven individuals of *Clemmys muhlenbergi*. One turtle was tracked to its hibernaculum where the transmitter continued to function until the following spring when the specimen was removed from a mud and ice slurry. Only one package was dislodged from the turtle.

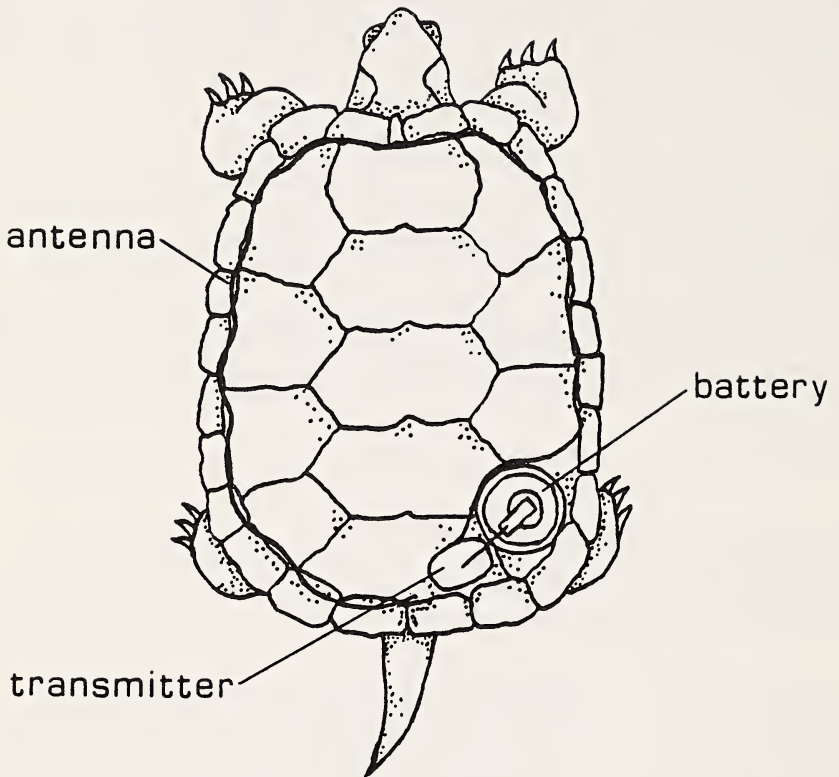


Figure 1. Transmitter package (battery, transmitter, antenna) are attached to the carapace using silicone rubber sealant.

Acknowledgments

I sincerely wish to thank Howard Reinert for his expertise and advice for this project. I also wish to thank Ken Friedman and Marty Berg, Bob Johnson and Dick Carey at Pennsylvania Power & Light and Clark Shiffer from the Pennsylvania Fish Commission for their commitment to this project. Special thanks to Janice Larson for her review of the manuscript.

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Accepted: 28 March 1984

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NEWS AND NOTES:

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KEITH A HARDING, *Gunnislake, Cornwall, UK*

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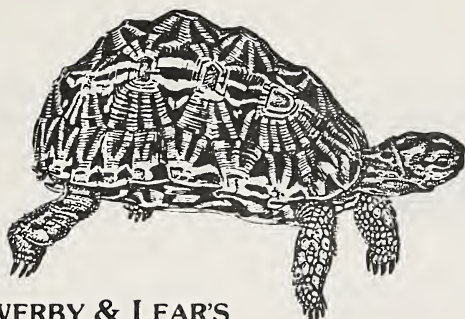
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The Institute for Herpetological Research is pleased to announce that its new publication, *The Bacterial Diseases of Reptiles*, will be available in May 1984. Over 100 pages in length, this book contains the most advanced and up to date information on the epidemiology, identification, diagnosis and treatment of these diseases. Information on the newest antibiotics including proper antibiotic selection and drug dosages is included. Identification of simple and resistant forms of the common diseases of reptiles, as well as detailed techniques of treatment of each disease are covered by this book. There are also descriptions of the fundamental husbandry techniques for treating reptile diseases, including preparation and calculation of antibiotics. A section of full color photographs of all of the diseases is also present.

The Bacterial Diseases of Reptiles is available for \$20.00, book rate postage included. Please add \$1.25 for first class postage. Copies may be obtained by writing to the Institute at P.O. Box 2227, Stanford, California 94305.

NEWS AND NOTES:



JUST REISSUED

SOWERBY & LEAR'S

TORTOISES, TERRAPINS AND TURTLES

This book is generally regarded as the finest atlas of turtle illustrations ever produced, drawn by the famous nineteenth century artists James de Carle Sowerby and Edward Lear. The short text is by John Edward Gray. Originally published in London in 1872, the book was reprinted by the Society for the Study of Amphibians and Reptiles in 1970 but this edition was sold out some years ago. The reprint includes an extensive introduction by Ernest E. Williams, of Harvard University, detailing the history of the book and its authors and artists, and equating the scientific names to current nomenclature.

The atlas includes 61 black-and-white plates of turtles, depicting species from all parts of the world. The book measures 8½ by 11 inches (about 22 by 28 cm) and is clothbound. Copies can be purchased for \$20.00 from the SSAR Publications Secretary, Douglas H. Taylor, Department of Zoology, Miami University, Oxford, Ohio 45056, U.S.A. The price includes postage in the U.S.A.; only the *additional* surface mailing costs will be charged for non-U.S.A. shipments. Payments from overseas should be made in U.S.A. funds, by International Money Order, or may be charged to MasterCard or VISA (include account number and expiration date of credit card).

SSAR also publishes *Journal of Herpetology*, *Herpetological Review*, *Facsimile Reprints in Herpetology*, *Herpetological Circulars*, *Catalogue of American Amphibians and Reptiles*, *Contributions to Herpetology* and *Recent Herpetological Literature*. Inquiries about membership in the Society or purchase of back issues can be addressed to Dr. Taylor.

NEWS AND NOTES:

THE NEW JERSEY STATE MUSEUM Cultural Center West State Street Trenton 08625

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NEW JERSEY STATE MUSEUM COLLECTION

The New Jersey State Museum has recently completed renovation of a new collection storage range for fishes, amphibians and reptiles. The ichthyological collection of The Wetlands Institute, made mainly by Lehigh University and Stockton State College, and the herpetological collection of the late James D. Anderson of Rutgers University have been donated to the museum and are now catalogued and incorporated into the museum's range. The collection is made up of more than 2,000 lots of fishes, amphibians and reptiles collected from across the State and its coastal waters during the 1950's, 1960's and 1970's. The amphibian collection is strong in series lots, particularly relating to specimens of Ambystoma adults and larvae, while the fish collection is strongest in bay and estuarine species. Computerization of the records of this collection will be undertaken this coming year. Persons interested in examining parts of this collection may do so by contacting Raymond J. Stein, Bureau of Science, New Jersey State Museum, CN-530, Trenton, New Jersey 08625.

NEWS AND NOTES:

Northern California Herpetological Society
706 Arnold St., Davis, CA. 95616

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TO: All Herpetological Societies/Interested Groups
FROM: The Northern California Herpetological Society
SUBJECT: Preliminary Announcement of the 1985 Conference on Captive Propagation of Reptiles and Amphibians and Availability of the 1983 Conference Proceedings

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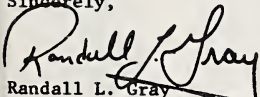
The Northern California Herpetological Society is sponsoring its second conference on the CAPTIVE PROPAGATION AND HUSBANDRY OF REPTILES AND AMPHIBIANS. This two day conference will be held on January 19 and 20, 1985 in Davis, California. The conference will feature both keynote speakers and contributed papers. All papers will be published in the proceedings.

All herpetologists, both amateur and professional, are invited to attend and/or present a paper at the conference. Please submit a short abstract of your paper by August 30, 1984 to Randall L. Gray, NCHS, 706 Arnold St., Davis, CA 95616.

The proceedings of the 1983 conference will be available in April 1984. A prepublication sale will be in effect until April 15, 1984. You can pre-order a copy of the proceedings by sending a check or money order for \$10 to the following address by April 15th; NCHS, 706 Arnold St., Davis, CA 95616. After April 15th the price of the proceedings will be \$13.

Thank you for your assistance. If you have any questions please contact me at the above address or phone (916) 753-0866.

Sincerely,


Randall L. Gray

NOTES:

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 May 31 - Abstracts to Program Chairman, Dr. Richard Ross, 1440 Hamilton Avenue, Palo Alto, -CA 94301.
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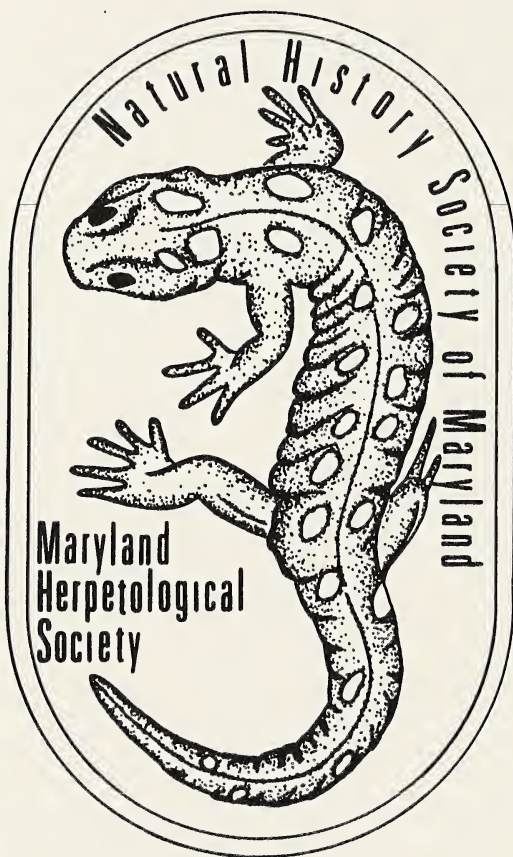
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The Maryland Herpetological Society
Department of Herpetology
Natural History Society of Maryland, Inc.
2643 North Charles Street
Baltimore, Maryland 21218



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Herpetological Society



DEPARTMENT OF HERPETOLOGY

THE NATURAL HISTORY SOCIETY OF MARYLAND, INC.



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The Maryland Herpetological Society
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Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

THE LIFE HISTORY AND STATUS OF THE EASTERN
TIGER SALAMANDER, *Ambystoma tigrinum*
tigrinum (GREEN) IN MARYLAND

Charles J. Stine

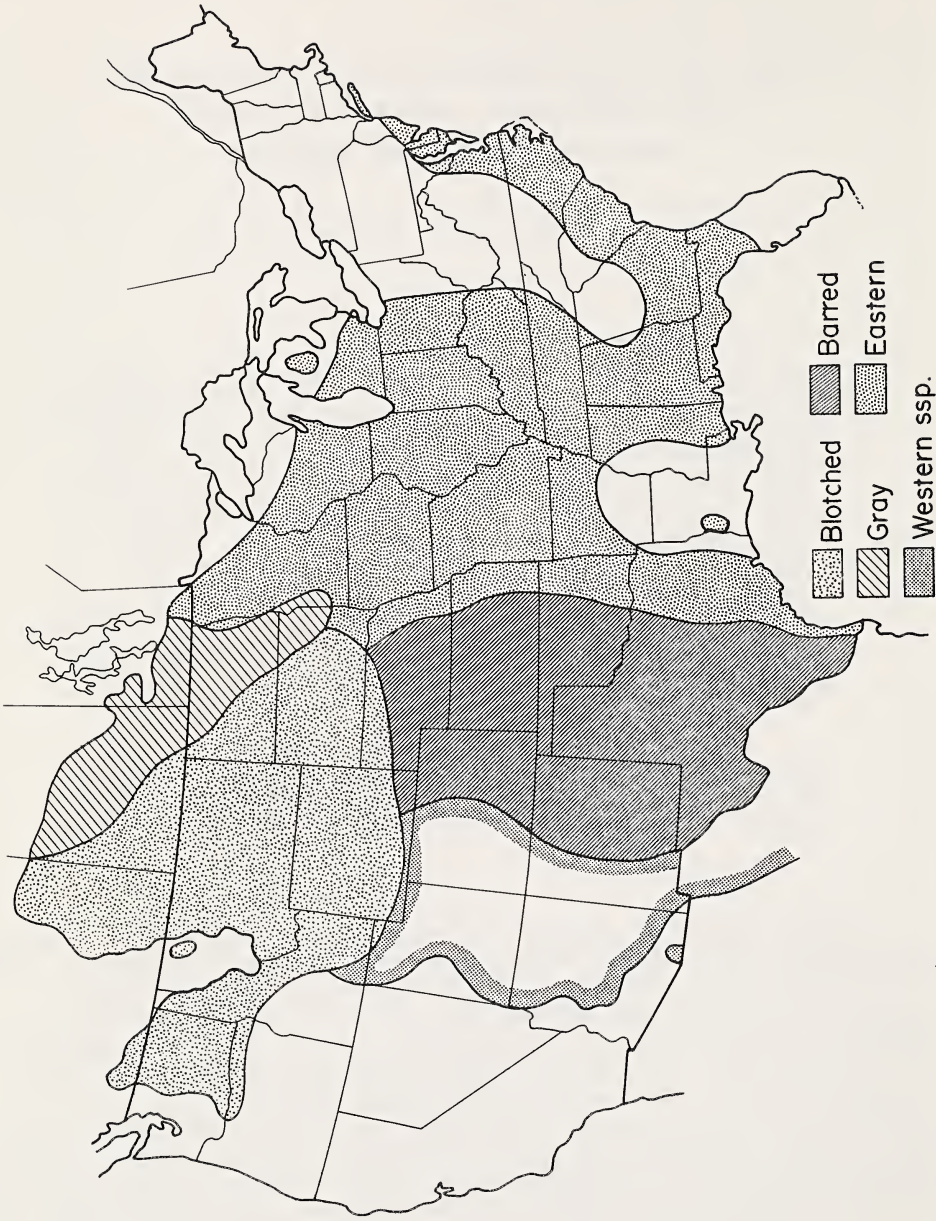
Abstract

An historical review is given of investigation of *A. t. tigrinum* in Maryland from 1938 to 1983. *Tigrinum* breed as early as November and as late as March. They apparently do not mass migrate. Adult salamanders grow rapidly increasing up to 21.5% in length in 10-11 months. Females lay 350-450 eggs and loose an average of 7.3g after deposition. Eggs take 29-33 days to hatch. Male secondary sex characters of keeled tails and swollen vents diminished 0.8 and 1.4mm respectively over an eight day period. Total egg production from 1976 to 1983 ranged from 2,693 to 14,040. Egg mortality varied with locality and year and appeared correlated with *Chlamydomonas* infestation. The larval period ranged from 23-28 weeks. Larval survival was 3.6%. Post breeding location of *tigrinum* in Maryland was not determined. Comparative differences in prey, pH, and dissolved oxygen in two breeding ponds suggest that lentic succession produces abiotic and biotic changes affecting survival of *tigrinum* demes. Population estimates of selected Maryland demes range up to 216. These estimates are comparable to population estimates for New Jersey but less than those for Indiana.

The range of *tigrinum* in Maryland has been significantly reduced, compared to the known range in the 1950's, due primarily to habitat destruction and natural succession. The result of translocation of larvae to establish a breeding deme on the Western Shore is presently unknown.

Of the twenty-one species and subspecies of salamanders recorded from Maryland, four species belong to the genus *Ambystoma* (Harris, 1975). All are blunt headed, fossorial, lung breathing salamanders with morphological and ethological similarities but different ecological-reproductive strategies, population densities and distributional patterns. One of these four is the eastern tiger salamander *Ambystoma tigrinum tigrinum* (Plate 1). Sever and Dineen (1978) state that the tiger salamander *A. tigrinum* is the most widely distributed species of salamander in the world and that seven subspecies are recognized (Figure 1). *Ambystoma tigrinum* is distributed from southern central Canada south to Florida and Mexico but is absent from New England, the Appalachians and the far west (Behler and King, 1979) (Figure 1). The eastern tiger salamander, *A. t. tigrinum*, the subspecies with which we are concerned, ranges roughly from Long Island to Northern Florida, Ohio to Minnesota and south to the Gulf (Conant, 1975). In Maryland, *tigrinum* has been found, in the geologic present, exclusively on the Coastal Plain

Figure 1



General distribution of subspecies of the tiger salamander, *Ambystoma tigrinum* in North America (After Conant, 1975).

(Figure 1). Holman (1977) has shown however, that the tiger salamander, existed in the Appalachian region of Maryland during the Pleistocene (Kansan) 600,000 years ago. In Virginia *tigrinum* has been recorded from the inner Coastal Plain and the Piedmont Plateau (Funderburg et al., 1974).

Materials and Methods

Intermittent field trips were made throughout the Maryland Coastal Plain from 1952 to 1977 to observe tiger salamander behavior and to locate breeding sites. An estimated 400 hours were spent in field activity. From 1977 to 1980 an additional 180 hours were spent in aerial reconnaissance in a distribution survey for the Department of Natural Resources. From 1980 to 1983, 200 hours were spent determining population density and quantifying ecological information. Air temperature was determined by Lamotte thermometer 1066. Water temperature and dissolved oxygen were determined by model 512 YSI oxygen meter using probe model 3739. pH was obtained with model HA Lamotte pH meter.

Chronology of Investigation

This history of field activities and research concerning *tigrinum* was reconstructed from the literature, the author's field notes and corroboration.

The eastern tiger salamander was first recorded in Maryland from Vienna, Dorchester County near "the old water works" in February 1933 by E. E. Lamkin (Netting, 1938). That adult specimen is preserved in the United States National Museum (USNM 89904). A second specimen was collected by R. H. McCauley, Jr. (USNM 104405) from Denton, Caroline County in September 1937. Another specimen from Denton was collected by F. R. Deardorff in April 1938. This specimen is preserved at Cornell University (CU3539). James Fowler, who has elucidated the distribution of many species of Maryland amphibians, collected eggs of *tigrinum* from Federalsburg and Hollingsworth Crossroads in Caroline County on March 17, 1941 and March 31, 1946 respectively.

On February 22, 1952 Stine, Fowler and Simmons found approximately 30 egg masses of *tigrinum* in a pond at Golts, Kent County (Plate 2); 15 egg masses in a cut-over corn field pond on the west edge of the Frey Farm, 100 yards south of Massey-Delaware Line Road, Kent County (Plate 3); a single egg mass at Carson Corner, Queen Annes County and "several" egg masses at Baltimore Corner, Caroline County (Plate 4). After that field trip the author began an intermittent odyssey into the ecology of *tigrinum* that has persisted for 32 years. Sometime during the early 50's, I found a single egg mass and an adult male in a small shallow pond in an open field south of the Frey Farm buildings. In 1957 following road construction, a gravel pit borrow pond was created several hundred yards from

the Frey Farm Pond adjacent to Massey-Delaware Line Road three miles east of Massey (Plate 5). Within 12 to 18 months this pond had breeding *tigrinum* and later became the major reproductive site for the species in the state.

Stine (1953) summarized the current knowledge of the distribution of *tigrinum* in Maryland. On February 24, 1953 Stine and H. Campbell located one egg mass in a gravel pit pond in Somerset County, one mile north of Westover. Stine and Fowler found *tigrinum* larvae in a pond near La Plata, Charles County on May 27, 1953. Three adult males were observed at this site by R. Simmons February 24, 1961 and Stine and H. Harris observed adults there in February, 1962. On February 7, 1963 69 adult *tigrinum* were captured, marked, taken to the laboratory and later released (February 21, 1963) in the La Plata Pond by Stine and Harris. Simmons and Harris observed about 20 additional *tigrinum* in the La Plata Pond on February 11, 1963, suggesting a population density of 89 or more at this site. A short time later the La Plata Pond was destroyed during the construction of a golf course. At that time the United States was seven years away from the rise of environmentalism and concern for endangered species expressed in the creation of the National Environmental Protection Agency in 1970. In 1971, the Maryland General Assembly passed an Endangered Species Act, reflecting local concern for endangered non-game wildlife.

In September 1962, Frank Groves, Curator of Reptiles and Amphibians of the Baltimore Zoo, received an adult *tigrinum* from Grace Moyle, Arnold, Anne Arundel County. This specimen had been found on a walkway (Harris, pers. comm. 1983). Harris and Simmons independently investigated the area, finding pine forest without ponds, and considered the region incompatible to the ecologic requirements of *tigrinum*. It was hypothesized that the specimen had been incorporated in an earth ball on shrubbery shipped to the Moyle's from the Delmarva (Simmons, pers. comm. 1983).

On March 26, 1964 Stine found one egg mass in a small roadside pond on State Route 369 southwest of Bishopville, Worcester County.

Cooper (1960) and Harris (See Cooper, 1965; 1966, 1975) summarized distribution records of Maryland's herpetofauna including *tigrinum*. On June 15, 1972 L.R. Franz and D.S. Lee (Franz, 1972) documented the presence of *tigrinum* at Massey, collecting 11 mature larvae. These specimens are preserved in the Florida State Museum (FSM 39087-39097). By the late 60's efforts to further delineate the Maryland range of *tigrinum* essentially ceased and investigators began to study its ecology. Lee (1973) reported on the temporal aspects of the breeding of selected Maryland amphibians including *tigrinum*, and Lee and Franz (1974) studied the diversity of aquatic species preyed upon by *tigrinum* larvae. Cooper et al. (1973) commented briefly on endangered status, habitat requirements, survivorship and predators of *tigrinum*. Lee (1975) reviewed, anecdotally, the general ecology of *tigrinum*. In 1976-1977 Robert Johnson discovered three new breeding sites in Kent County, all within a 5 km radius of

Massey Pond. These sites are known as Golts Garbage Pond, Fred Road Pond, and TP3 Pond (Plates 6,7). Van Deusen (1979) and Johnson and Van Deusen (1979) discussed the range, habitat preferences and limiting factors affecting the status of *tigrinum* in Maryland. Several authors (Lee, 1975; Van Deusen, 1979 and Johnson, 1980), discussing the former range of *tigrinum* in Maryland, have overlooked the Somerset County record.

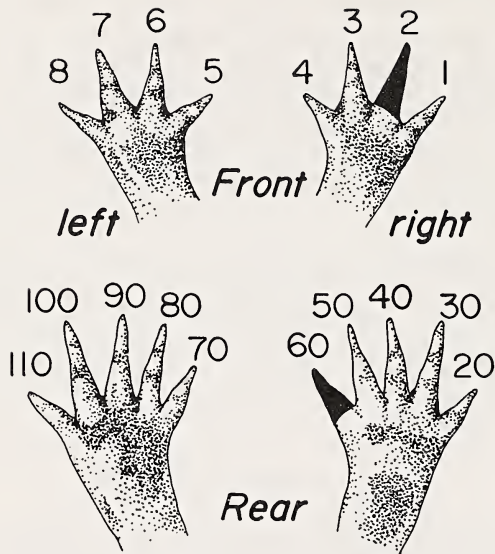
In 1977 a three year study on *tigrinum* distribution was completed for the Maryland Department of Natural Resources, Wildlife Administration (Stine, 1979). Much of the information contained in this report resulted from that study. In 1983 Arnold Norden and Mary Broznan of the Maryland Natural Heritage Program identified two additional breeding sites in Caroline County. These sites are known as the Mt. Zion and Bridgetown breeding localities.

It is interesting to note that the type of investigation described above reflects the general trend in biological fieldwork over the 32 year period described, i.e., collecting and preserving specimens for understanding of taxonomy and distribution, to more informed ecologic and behavioral studies, without preservation of specimens, but related to conservation of species.

Individual Identification

Identifying individual salamanders is essential for determining population density, growth, sex ratio, individual variation and movement. Many methods have been proposed. Clark (1971) proposes the use of branding, and Seale and Borass (1974) advocate subcutaneous injection of an organic dye. Radioactive Tantalum-182 has been used to determine homing behavior, orientation and home range of salamanders (Madison and Shoop, 1970). I prefer to use toe clipping, singly or in combination according to a predetermined code. In the code used, the front feet (four toes each) are numbered one to eight from right to left, the hind feet (five toes each) are numbered 20 to 110 in increments of 10. For example, to illustrate the value of individual marking No. 2,60 (RF second toe from the outside, RR fifth toe from outside) is a male (Figure 2). When first captured in Massey Pond on February 5, 1983 No. 2,60 weighed 29.4 gm and measured 206 mm in length overall. Recaptured December 8, 1983 it weighed 33.8 gm and measured 222 mm overall - an increase of 4.4 gm (7.7%) in weight and 16 mm (13.9%) in length over a 10 month period.

Figure 2



Toe clipping scheme for identifying individual eastern tiger salamanders, *Ambystoma t. tigrinum*. Shaded toes identifying a male, no. 2,60 captured February 5, 1983 marked, released and recaptured December 8, 1983. During the interim it had gained 7.7% in weight and 13.9% in length.

Species Description

The Eastern tiger salamander *A. t. tigrinum* is a robust animal with a broad head and small eyes. *Ambystoma t. tigrinum* is the third largest species of tailed amphibian in Maryland, exceeded in size only by the hellbender, *Cryptobranchus alleganiensis alleganiensis* and the mudpuppy, *Necturus maculosus maculosus*. Variations in length and weight of breeding males and females are presented in Table 1.

Table 1

Average and range of length and weight of breeding male and female eastern tiger salamanders, *Ambystoma t. tigrinum* from Massey Pond and breeding males from TP3 Pond, Kent County, Maryland, December 1982-February 1983.

	<u>Massey</u>			
	Males	(N = 25)	Females	(N = 13)
	\bar{X}	Range	\bar{X}	Range
Length (mm)	200.6	165-230	175.5	155-200
Weight (gm)	28.4	20.7-37.3	27.9	20.6-42.0

	<u>TP3</u>			
	Males	(N = 6)		
	\bar{X}	Range		
Length (mm)	217.6	207-240	-	-
Weight (gm)	27.6	24.5-32.0	-	-

The color and pattern of *tigrinum* are variable, but generally consist of a dorsal ground color of dull black to brown with light olive or yellowish blotches and lateral bars (Plate 8). The belly is dark with small olive-yellow blotches. Occasionally there are tinges of pink or red on the sides of the males during the reproductive period.

Growth

In Maryland, adult *tigrinum* appear to have a relatively high growth rate. Changes in weight and length for adults are presented in Table 2. These data suggest that length may increase as much as 21.5% for males and 20.8% for females from one breeding season to the next. The increase in weight of individuals, as shown, may be due in part to increase in length but also to feeding prior to reproduction while in a terrestrial mode and reduced metabolism during hibernation. The weight loss of three males (5; 1,5; 8,20) in the pond during a single breeding season may be due to increased energy expenditure associated with reproductive behavior, i.e., swimming, spermatophore deposition and perhaps agonistic behavior. Weight loss also suggests lack of feeding during the aquatic phase of adults. It is assumed that the notable increase in weight of the single female *tigrinum* (63.7%) is due in part to egg development. Growth rates probably differ for different age classes.

Table 2

Increase in weight and length of male and female eastern tiger salamanders *Ambystoma t. tigrinum* captured, marked and recaptured in Massey Pond, Kent County, Maryland

Specimen No.	Sex	Date Captured		Wgt. gm	Length OA mm	Date Recaptured	Time Elapsed/Days	Wgt. gm	Length OA mm	Incr/Decr Wgt. gm		Incr/Decr Length mm		% Incr/Decr Weight gm		% Incr/Decr Length OA mm	
5	M	12/29/82	26.6	205	205	1/15/83	17	25.7	--	-9	-	-3.4	-	-3.4	-	-	-
1.5	M	1/04/83	26.8	203	203	11/29/83	328	29.3	217	+2.5	+14	+9.3	+6.9	+9.3	+6.9	+6.9	+6.9
20	M	12/30/82	30.5	191	191	2/13/84	76	26.0	217	-3.3	0	-11.3		-11.3			
100	M	1/11/83	27.4	216	216	11/29/83	332	37.7	232	+7.2	+41	+23.6	+21.5	+23.6	+21.5	+21.5	+21.5
20,80	M	2/22/83	31.6	198	198	12/02/83	325	41.2	227	+13.8	+11	+50.4	+5.1	+50.4	+5.1	+5.1	+5.1
2,60	M	2/05/83	29.4	206	206	11/29/83	308	35.9	225	+4.3	+27	+13.6	+13.6	+13.6	+13.6	+13.6	+13.6
8,20	M	12/02/83	29.9	201	201	12/08/83	306	33.8	222	+4.4	+16	+14.9	+7.8	+14.9	+7.8	+7.8	+7.8
110	F	1/11/83	24.5	168	168	12/13/83	11	28.2	201	-1.7	0	-5.7		-5.7			
						12/02/83	325	40.1	203	+15.6	+35	+63.7	+20.8	+63.7	+20.8	+20.8	+20.8
										Range	Range	Range	Range	Range	Range	Range	Range
										11 - 328	+2.5 - 15.6	11 - 35	11 - 35	+9.3 - 63.7	51.8 - 20.8	51.8 - 20.8	51.8 - 20.8
										\bar{x} = 225.3	\bar{x} = 7.9	\bar{x} = 24	\bar{x} = 24	\bar{x} = +29.3	\bar{x} = 12.6%	\bar{x} = 12.6%	
											-9 - 3.3			-3.4 - 11.3			
											\bar{x} = 1.9			\bar{x} = -6.8			

Sexual Dimorphism

During the breeding season male *tigrinum* may be distinguished from the female by an enlarged vent (cloacal opening) and higher tail (Plate 9). The abdominal region of a female with eggs is more rotund than the abdomen of a male (Plate 10). These morphological features are undoubtedly under hormonal control and diminish as reproductive activity wanes. Data are presented in Table 3 showing the reduction in tail height and cloacal width over time in males captured, marked-released and recaptured in Massey Pond. Reproductive colors present on some males also diminished over time. For example, a male (No. 1,8) captured January 11, 1983 had an overlay of burnt sienna on the lower half of both sides and behind the head. This color was completely gone when it was recaptured 15 days later on January 26, 1983. The function of this transient dorso-lateral coloring is unknown.

Table 3
Decrease in secondary sex characteristics of male eastern
tiger salamanders, *Ambystoma t. tigrinum* in Massey Pond,
Kent County, Maryland 1983

Specimen No. (Toe clip)	Tail height in mm (at capture)	Cloacal width in mm (at capture)	Time lapsed in days from capture to recapture	Tail height (mm) (loss at recapture)	Cloacal width (mm) (loss at recapture)
1	20	20	28	18 (2)	17 (3)
4	20	15	23	19 (1)	13 (2)
5	18	18	18	17 (1)	16 (2)
1,5	17	15	23	17 (0)	15 (1)
1,8	19	17	16	19 (0)	17 (0)
2,5	18	15	16	17 (2)	14 (1)
100	20	17	5	20 (0)	16 (1)
20,70	21	18	23	19 (2)	16 (2)
20,90	20	15	12	20 (0)	15 (0)
20,110	16	15	23	16 (0)	13 (2)
Total 10	Range 17-21	Range 15-20	Range \bar{x} 18.7	Range 0-2 \bar{x} loss = (.8)	Range 0-3 \bar{x} loss = (1.4)

Reproductive Cycle

Much of what is believed regarding *tigrinum* in Maryland is extrapolated from studies on other subspecies, or on this subspecies conducted outside the state. These data, in conjunction with observations from the author's notes and research in Maryland, have been utilized in the following summary of the ecology and ethology of *tigrinum*. Adults are essentially nocturnal although I have, on several occasions, seen one or two swimming in a pond during the day. During a late fall warm period or winter thaw, adults of both sexes appear in the breeding pond. Day-time temperatures for one or two days preceeding their appearance may be as high as 21°C (January 16, 1953) or as low as 4.5°C (March 1982), often they are around 10°C. Frequently the elevated temperatures are accompanied by rain, melting snow and fog. Minimal temperatures for reproductive activity are about 4.5°C. Sever and Dineen (1978) found the highest concentrations of *tigrinum* in a pond in Indiana when air temperature was in the 8-16°C range.

Breeding at Massey Pond began in 1978 on December 8 (R. H. Johnson, pers. comm.). In 1972 the earliest observed *tigrinum* was December 20 (Hertl, 1973). During the 1982-83 season the first eggs at Massey were observed December 22, 1982 indicating reproduction had commenced. The earliest I have recorded the appearance of breeding *tigrinum* in Maryland is November 28, 1983 at Massey Pond. The latest known record for inception of breeding is March 10 (Lee, 1973). From December 29, 1982 to January 4, 1983 only males were captured in Massey Pond. On January 8 the first female was collected there. On January 11, nine new females were taken and marked. A total of 48 *tigrinum* (34 males; 14 females) had been active in Massey Pond. On February 22 a previously unmarked male, the last specimen to be observed for the season, was captured. The reproductive period from beginning to end in 1982-1983 extended for 63 days. This does not mean that all breeding *tigrinum* were in the pond for that period, but that 63 days lapsed from the beginning to the end of reproductive activity.

It is believed that male *tigrinum* preceed the females to the pond. Lee (1975) states that "male salamanders arrive at the ponds first, usually several days and sometimes several weeks before the females". This assumption may be questioned. Perhaps observers have not been at breeding ponds early enough to find males and females simultaneously. Additionally, females are more secretive than males. For example in Massey Pond, on November 18, 1983, the water was 26 cm deep, insufficient for egg deposition and no salamanders were observed. On November 29, 1983, following several days of air temperature between 10-15°C and several periods of extended rain, the water depth was 53 cm, sufficient for egg deposition. Both males (n=9) and females (n=3) were present at that time.

Investigators have written of *tigrinum* migrating to breeding ponds, but no one in Maryland has recorded a mass migration as frequently occurs with the spotted salamander *A. maculatum*. Migration of *tigrinum* has been alluded to in New York (Bishop, 1941). Sever and Dineen (1978) caught 14 *tigrinum* in pit traps over a period of a month, migrating to a pond in Indiana. These migrants represented a small percentage of the total population. No mention is made by Sever and Dineen (1978) of a mass migration. Johnson (pers. comm.) captured three adults (January 8, 1978) in pit traps adjacent to a fence enclosing TP3 Pond in Kent County. One, a male, was caught outside the fence which suggests that some individuals may spend the non-reproductive part of the year some distance from the pond, moving to it at time of reproduction. Johnson notes that on that date he "was able to pull up large chunks of frozen ground. Underneath, the ground was very soft (completely saturated)." Considering the fossorial behavior of *tigrinum*, migration may occur in part beneath the surface. Duellman (1954) found 274 *tigrinum* in a 30 hour period in the fall, moving randomly on a road following a heavy rain in southeast Michigan. Duellman (1954) did not interpret the movements as a fall migration. Bishop (1941) notes that some adult *tigrinum* on Long Island, New York leave breeding ponds after laying eggs, and some remain in ponds all year long. My view is that, in Maryland, some *tigrinum* burrow under the edges of the pond after the reproductive period. This view has recently been confirmed by Semlitsch (1983) who tracked an emigrating male with radioactive Tantalum - 182 from the pond to a distance of 12 m ashore. It was found an average of 12 cm below ground. In the fall, the pond periphery frequently recedes, leaving the salamanders isolated, at varying distances, from water. Later, following a cold period, thaw and precipitation extend the pond, saturating and loosening the soil, enabling *tigrinum* to "re-enter" the pond nocturnally from the bottom. In support of this hypothesis, on November 29, 1983 when *tigrinum* were first observed at Massey Pond, all of 11 adults captured were found along the edge of the pond where water was about 18-20 cm deep. No adults were observed at that time in the central deepest (54 cm) part of the pond. By December 2, 1983 when the first eggs were observed, the situation was reversed and salamanders were captured in the deeper part of the pond but not observed in the shallow edges. Planned radio-transmitter implantation will test this hypothesis. Perhaps small population density precludes a discernable mass migration.

Reproductive congregations and general activity may take place under ice. Stine and Harris collected 69 *tigrinum* moving about in a small area under one to two inches of ice in the La Plata Pond February 7, 1963. The author observed a spent female swim by a window cut in three inches of ice, in Massey Pond January 22, 1983.

During the reproductive period the males deposit pyramidally shaped gelatinous spermatophores having a sperm cap containing sperm, from their cloacas onto the pond bottom. Bishop (1941) observed male *tigrinum* in New York holding their bodies rigid and extending their legs out, off the bottom during spermatophore deposition. I have observed this position in

several males in Massey Pond on January 26, 1983, but have not witnessed deposition. I found two spermatophores at Golts Pond on the leafy bottom in 1953. These two, the only one I have seen, were about 8 mm high (Plate 11). Anderson (1970) collected and described 15 spermatophores of *tigrinum* from a pond in New Jersey. Johnson (pers. comm.), after two years of intensive field observation, found spermatophores on April 1, 1983 in TP3 Pond in water 5.25 cm deep. The spermatophores described by Anderson (1970) were in water 15-20 cm deep. The paucity of *tigrinum* spermatophores in Maryland breeding ponds may be more apparent than real. Arnold (1977) states that a single male *tigrinum* deposits from 8-37 spermatophores in a night compared to 81 for a male spotted salamander, *A. maculatum*. Arnold (1977) also states that *tigrinum* spermatophores may be covered by spermatophores of competing males. Spermatophore covering would effectively reduce the number of spermatophores visible on the substrate. Silt activated by investigators in the pond may also cover spermatophores, hindering observation. Females may utilize spermatophores soon after deposition thus preventing observation.

When weather conditions are optimal (10°C+ air temperature and light rain), and if sufficiently stimulated, male and female *tigrinum* nose each other's cloacal region. I observed this behavior one rainy night (February 9, 1956) at Golts, when the air temperature was 10°C. Bishop (1941) states that a stimulated captive female *tigrinum* applied her snout to the male's cloaca then passed her body and vent over the spermatophore, after deposition. Arnold (1977) states that in all salamanders, the male contacts the female's epidermis with his snout before spermatophore deposition which suggests chemoreception as a mechanism for sex and species identification. Concentration of pheromones in the deeper part of a pond may also account for the general localization of reproductive behavior, concentration of males in a lek and egg deposition. Female *tigrinum* reportedly "pick up" spermatophores into their cloacal, fertilizing eggs. Anderson (1970) suggests that the entire spermatophore is taken up by the female and not just the sperm cap. He also suggests eggs may be deposited within 36 hours after fertilization in New Jersey. Although I have no data for Maryland females, the time to deposition is likely to be the same.

Egg Deposition

When laying eggs, female *tigrinum* assume a typical posture, grasping vegetation with the hind legs, arching the back upward and tail and cloaca downward. The trunk and head may be vertical, at an angle or horizontal to the substrate. Front legs are usually free (Plate 12). I observed three female *tigrinum* depositing eggs on twigs in "hunched-over" positions at 11 p.m. in Golts Pond (February 9, 1956). They were sluggish and were not disturbed by my presence. Females deposit fertilized eggs on panic grass, *Panicum agristoides* at varying depths in the water. Old stalks of narrow-leaved cattail, *Typha angustifolia* and narrow fallen tree branches are also utilized. Narrow bamboo stakes used by the author to designate location of egg clusters have also been

used by female *tigrinum*. Egg deposition is usually sufficiently deep to ensure against freezing. Perturbations in weather however can affect the clutch success. On December 22, 1983 Massey Pond was shallow. The first egg masses of the season were deposited flat against the substrate, unattached to vegetation. The water did not freeze to this depth (21 cm deep) and the eggs survived. On March 4, 1977, R. Johnson (pers. comm.) found about 100 *tigrinum* egg masses deposited 7.8-10.5 cm below the surface. Maximum water depth was 32 cm. By March 13, 1977, following 9 days without rain the maximum water depth was 10.5 cm and 60% of the pond was dry. All eggs in the dry area were destroyed. This suggests plasticity of egg deposition behavior adjusting to water level. Johnson (unpublished data) conducted an extensive study of the depth of egg masses at Massey and TP3 Ponds in 1978. A summary of these data are presented in Table 4. Based on capture, mark and recapture studies, females average a loss of 7.3 gm after egg deposition. Data are presented in Table 5.

Table 4

Range and average depth of egg masses of eastern tiger salamander, *Ambystoma t. tigrinum* deposited in TP3 and Massey Ponds Kent County, Maryland, 1978. (R. H. Johnson, 1978, unpublished data)

Location	N	Water depth (cm)		Depth (cm) from mid egg mass to surface	
		Range	\bar{X}	Range	\bar{X}
TP3	24	39-107	79	21-84	62
Massey	127	70-115	66	47-97	53

Table 5

Weight loss (gm) after egg deposition in four female eastern tiger salamanders, *Ambystoma t. tigrinum* from Massey Pond, Kent County, Maryland 1983

Date Captured	Date Recaptured	Female Number	Weight (gm) (with eggs) at capture	Weight (gm) (after deposition) at recapture	Weight loss (gm)	% Loss
1/11/83	1/15/83	1,6	28.0	21.4	6.6	23.6
1/11/83	1/22/83	1,7	22.1	16.5	5.6	25.3
1/11/83	1/15/83	50	41.9	32.1	9.8	23.4
1/11/83	1/15/83	60	25.5	18.4	7.1	27.8

$\bar{x} = 7.3$

Ambystoma t. tigrinum are reported to oviposit asynchronously in Northern Indiana (Sever and Dineen, 1978; Coutre and Sever, 1979) and New Jersey (Anderson et al., 1971). Egg deposition in Maryland also occurs asynchronously and sequentially once started, but may be interrupted if temperatures drop below freezing. Evidence of an extended temporal hiatus in egg deposition (for example, partly in December and partly in March) has not been substantiated to date but probably occurs some years. Data for 1982-83 egg deposition at Massey is presented in Table 6.

Table 6

Chronology of egg mass deposition of eastern tiger salamanders,
Ambystoma t. tigrinum in Massey Pond,
Kent County, Maryland 1982-83

<u>Date</u>	<u>Number new egg masses observed</u>
December 22, 1982	3
December 29, 1982	42
December 30, 1983	4
January 4, 1983	4
January 15, 1983	33
TOTAL	86

Egg masses of *tigrinum* tend to be oval, globular or oblong. Each egg is surrounded by gelatinous envelopes - the outer envelopes being fused to make up a common jelly layer. Bishop (1941) states that egg masses average 55 x 70 mm. The eggs are hygroscopic, their volume increasing substantially within several hours after deposition (Plate 13). The serous nature of *tigrinum* eggs is useful in distinguishing them from the more compact eggs of the spotted salamander, *A. maculatum* (Plates 14, 15). The number of eggs per mass varies. In New Jersey, Anderson et al. (1971) found a range of 26-127 eggs per mass and an average of 44.5. A sample of 37 egg masses at Massey in 1983 had a range of 17 to 144 eggs, and averaged 52.1 eggs per mass. Anderson et al. (1971a) states that a single female *tigrinum* probably deposits about 300 eggs in 5-8 masses in New Jersey. A captive female *tigrinum* from Golts Pond was observed depositing 344 eggs in 12 clusters in the laboratory (Stine et al., 1954). Another female from Massey Pond captured November 29, 1983 laid 394 eggs in the laboratory December 1, 1983. An approximation of these numbers of eggs (350) has been used in constructing population estimates for

several demes of *tigrinum* in Maryland. Investigators have been reluctant to remove eggs from breeding females and there are no published reports of numbers of eggs deposited by females *in vivo*, or additional laboratory observations in Maryland. Estimates for total egg production for seven years at Massey are presented in Table 7.

Table 7

Estimated number of eggs of eastern tiger salamander,
Ambystoma t. tigrinum deposited in Massey Pond,
Kent County, Maryland 1976-1983

<u>Year</u>	<u>Number of eggs</u>
1976-1977*	2,693
1977-1978*	3,384
1978-1979*	5,750
1979-1980*	7,500
1980-1981	no eggs - drought
1981-1982	14,040
1982-1983	4,480
	<hr/>
	$\bar{x} = 5,407$

*(R. H. Johnson, unpublished data)

Data regarding annual fluctuation of *tigrinum* egg production in Maryland (Table 7) may reflect yearly differences in weather, age class survival of females, food availability for adults and larvae, quantity and type of predators, sampling error and human intervention. The abundance of 14,040 eggs deposited in 1982 following a year of drought and no egg deposition suggests an intrinsic population regulating mechanism through changes in fertility, and variation around a mean of 5,407 eggs per year for the seven year period. It may also suggest that some females may breed biennially so that 1982 was a "double" year.

Mortality of eggs varies with breeding location and may reflect critical chemical and physical differences in sites. Data are presented in Table 8 comparing mortality for eggs at Massey and TP3. It is evident that mortality of eggs is substantially less at Massey ($\bar{x} = 8.0\%$) than at TP3 ($x = 58.3\%$): some egg masses of *tigrinum* contain a green alga, a species of *Chlamydomonas* that may influence survival. Percentage of eggs with algae in TP3 and Massey Ponds are presented in Table 9. Anderson (1971b) found a correlation between egg mortality and algae.

Stine and Eng (unpublished data) isolated (in a plastic frame covered with pantyhose) eight egg masses deposited on February 20, 1983 at Massey, translocating three masses to Golts, a pond no longer used by *tigrinum* as a breeding site. Those at Massey hatched March 21 (29 days incubation). Those at Golts (a more shaded pond) hatched March 25 (33 days incubation). The hatching of eggs translocated to Golts Pond was 100% suggesting water pollution was not a factor in the loss of Golts Pond as a breeding site. Although eggs can hatch at Golts, larvae may not be able to survive for reasons to be discussed later in this paper.

Table 8

Mortality of eggs of eastern tiger salamander, *Ambystoma t. tigrinum* in TP3, Massey and Golts Ponds, Kent County, Maryland

<u>Date</u>	<u>Location</u>	<u>No. egg masses</u>	<u>Estimated No. eggs</u>	<u>No. eggs alive</u>	<u>No. eggs dead</u>	<u>% Mortality</u>
*3/18/77	TP3	7	234	68	166	70.9
*3/25/78	TP3	27	612	332	280	45.7
*3/26-27/78	Massey	87	2065	1825	240	11.6
*4/01-02/78	Massey	21	688	661	27	3.9
3/21/82	Massey	5	358	328	30	8.4
**3/25/82	Golts	3	163	163	0	0.0

*(R. H. Johnson, unpublished data)

**Translocated from Massey to Golts

Table 9

Percentage of egg masses of eastern tiger salamander, *Ambystoma t. tigrinum* having a green alga, a species of *Chlamydomonas* in TP3 and Massey Ponds, Kent County, Maryland 1979

<u>Pond</u>	<u>Total egg masses observed</u>	<u>Number of egg masses with algae</u>	<u>% eggs with algae</u>
TP3	32	7	22.6
Massey	104	4	3.8

R. H. Johnson, unpublished data, 1979

Larval Period

Duration of larval stage of *tigrinum* in Maryland varies from year to year and is dependent on temperature, water level and available food. Bishop (1941) reported the length of the larval period for *tigrinum* in New York as 118-140 days, with metamorphosis occurring in August. Stine et al. (1954) reported a larval period of 110 days for Golts, and Hassinger et al. (1970) estimated the larval period in New Jersey at 75 days. In 1978 *tigrinum* eggs were first deposited in Maryland at Massey Pond on January 8. Larvae persisted into late August (a year having a wet spring and summer). Assuming an incubation of about 30 days the larval period that year lasted as long as 205 days. Franz (1972) reported collecting mature larvae June 17, 1972. In the 1982-83 season the first eggs were deposited December 22, 1982. The last larvae were seined on July 16, 1983, following a period of over eight weeks without appreciable rain. Thus the larval period in 1982-83 was as long as 161 days. Brandon and Bremer (1967) found *tigrinum* larvae in southern Illinois that overwintered without being neotenic. Overwintering of larvae has not been recorded in Maryland.

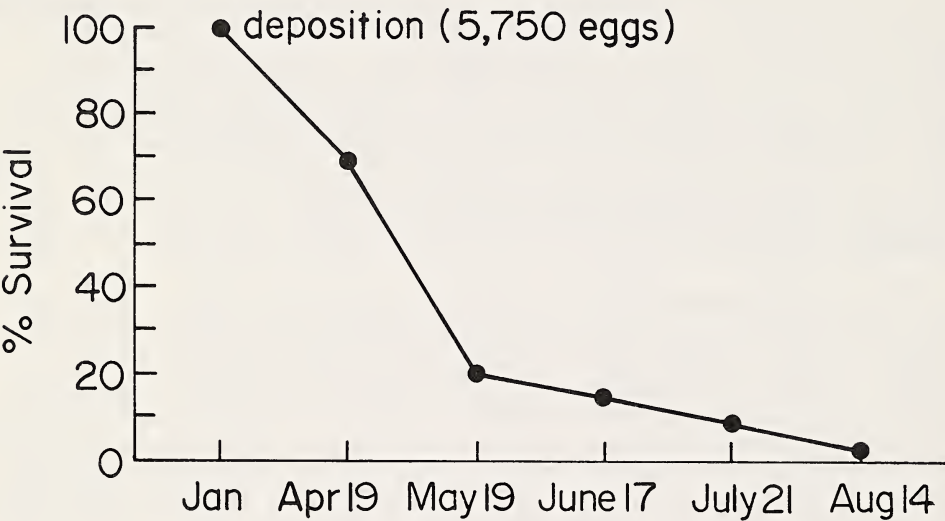
Recently hatched *tigrinum* larvae are small and dark. A series of 20 larvae from one egg mass at Massey (1983) average nearly 13 mm in overall length. Young larvae appear predominately cephalic with a slender, compressed, limbless body and slightly keeled tail. Recently hatched *tigrinum* larvae lack balancers. There is a light band extending from behind the small gills along the body to the tail. As larvae mature, the tail becomes more keeled and the gills become larger and more filamentous (Plates 16, 17). The light lateral band is diagnostic and helps one to distinguish *tigrinum* larvae from marbled salamander (*A. opacum*) larvae that may inhabit the same pond.

On hatching, *tigrinum* larvae settle onto the sediment on the pond bottom, or settle head up on vegetation, presumably until the yolk is absorbed. Periodic seining with fine mesh nets during 1982 has shown that larvae stay in the area of the pond where the bulk of the eggs were deposited for several weeks (1982). On June 21, 1978 the Massey Pond was divided into a grid of nine quadrates, each of which was systematically seined with 1.95 m sweeps. A total of 173 mature larvae were collected. Those collected were distributed accordingly: 16% in the deepest quadrat (where eggs are usually deposited), 43.3% in the peripheral sphagnaceous shallows and 40.7% in the peripheral non-sphagnaceous shallows. These data suggest a dispersal of larvae outward several weeks following hatching. Larvae at this time (n=89) ranged from 67-117 mm in length and averaged 100.1 mm.

Anderson et al. (1971a) found a mortality of 96.7% in New Jersey from egg deposition (early cleavage) to metamorphosis, a survivorship of 3.3%. Transect seining in Massey Pond in 1979 suggests a similar low survivorship in this Maryland deme. Starting with 5,750 (100%) eggs in January estimated survival at Massey was as follows: April 19 - 4,000

(69.5%); May 19 - 1,200 (20.8%); June 17 - 830 (14.4%); June 21 - 560 (9.7%) and August 14 - 210 (3.6%) (Figure 3). Massey may be an exceptional breeding site with optimal environmental factors but few data have been published for other breeding sites in Maryland for comparison.

Figure 3



Percent survival from egg deposition to transforming larvae of eastern tiger salamander, *Ambystoma t. tigrinum* in Massey Pond, Kent County, Maryland, 1978-79.

Ambystoma t. tigrinum larvae are mostly nocturnal opportunistic feeders preying upon a wide range of invertebrates. Lee and Franz (1974) examined the stomach contents of mature larvae from Massey and Golts. A summary of their data is presented in Table 10. Natural prey of adults has not been recorded in Maryland. In the laboratory adult *tigrinum* feed readily on earthworms. Lindquist and Bachman (1982) have found that, in the laboratory, detection and capture of earthworms by *tigrinum* was most efficient when visual and chemical prey stimuli were present.

Table 10

Summary of stomach contents of mature larvae of eastern tiger salamander, *Ambystoma t. tigrinum* in Massey and Golts Ponds, Kent County, Maryland (after Lee and Franz, 1974)

Food Item	Massey (N=42) %	Golts (N=9) %
Arthropoda		
Insecta	27.60	6.21
Crustacea	72.09	93.37
Mollusca	.16	.41
Amphibia	<u>.16</u>	<u></u>
TOTAL	100.0%	99.99%

Examination of Table 10 shows differences in the prey of *tigrinum* larvae at Massey and Golts Ponds suggesting successional differences in the two ponds. The successional process may account, in part (along with an increase in predators of *tigrinum* larvae), for the decline in breeding sites in the state. This matter will be discussed more fully later in this paper.

Predation

Predation of adult *tigrinum* in Maryland has not been reported. This is not surprising when one considers that *tigrinum* breed in brief, relatively warm intervals during extended cold and freezing periods. Such behavior is probably selected for avoidance of most predators such as aquatic reptiles and many species of mammals that are hibernating. Stine and Fox (unpublished data, 1981) found that the red-spotted newt *Notophthalmus v. viridescens* and *Dytiscus* beetles prey on *tigrinum* eggs. Dalrymple (1970) reported caddisfly larvae feeding on *tigrinum* eggs in New Jersey. Stine et al. (1954) observed predation of small *tigrinum* larvae by marbled salamander larvae, *A. opacum* (Plate 18). *Ambystoma opacum* lay eggs on the edge of ponds in early fall and larvae over-winter in ponds. *Opacum* larvae are larger than *tigrinum* larvae when the latter hatch.

Stine and Fox (unpublished data, 1982) working with potential predators from Massey Pond in the laboratory, found that *opacum* larvae preyed upon *tigrinum* larvae at the rate of .3 per day. They also noted that the rate of predation was not density dependent but reflected variables such as temperature and time of most recent feeding. Predator-prey roles were exchanged when size dominance reversed. When *tigrinum*

larvae registered a mean snout-vent length of 28.3 mm, and *opacum* 25.3 mm, *tigrinum* exhibited agonistic behavior i.e., a period of stalking followed by a sudden lunge and snapping of jaws with consumption of *opacum* body parts. It should be noted that this reversing interspecific predation, observed in the laboratory may represent a "cage effect". Occurrence in nature may be less common since *opacum* and *tigrinum* are thought to be spatially and temporally isolated in the same ponds (Anderson and Graham, 1967; Hassinger et al., 1970). The author, however, observed large *tigrinum* larvae feeding on *opacum* larvae in Golts Pond in the early 50's. Lee and Franz (1974) in their study of food of *tigrinum* larvae did not report *opacum* as prey.

In the laboratory, Stine and Fox (unpublished data, 1982) observed that a juvenile snapping turtle *Chelydra serpentina* (50 mm in length) was the most voracious predator, consuming 7.5 *tigrinum* larvae per day. A large snapping turtle, *C. serpentina* was captured in Massey Pond in July 1978, but not sacrificed to determine if it had preyed upon *tigrinum* larvae. The red-spotted newt, *N. v. viridescens* was a weak predator in the laboratory consuming .1 to .6 larvae per day during the study. Predation was also observed in Massey Pond, when on May 9, 1982 Fox observed a 3 cm *Dytiscus* beetle larva with a 4 cm *tigrinum* larva in its jaws. Predation by *Dytiscus* larvae has also been reported by Sever and Dineen (1978). Crayfish have been seen in Massey Pond and are potential predators. Polis (1981) states that intraspecific predation is common and widespread in the animal kingdom. Cannibalism by *tigrinum* has been reported in Texas (Reese, 1975; Rose and Amentrout, 1976). This behavior has not been observed in the field in Maryland. Stine and Fox (unpublished data, 1982) observed one case in the laboratory. It is not known how important cannibalism may be as a density dependent regulatory mechanism for populations of *tigrinum*, but it should be looked for. Other species observed at Massey Pond that are possible predators include the bull frog, *Rana catesbeiana*; eastern mud turtle, *Kinosternon suberbrum suberbrum*; ring-billed gull, *Larus delawarensis*; greater yellowlegs, *Totanus melanoleucus*; Canada goose, *Branta canadensis*; great blue heron, *Ardea herodias*; green heron, *Butorides virescens*; and raccoon, *Procyon l. lotor*. The eastern painted turtle, *Chrysemys picta picta* a potential predator, has been recorded from TP3 Pond. D. Loughy of the DNR (pers. comm.) who observes the Massey Pond frequently, reports that during the drought of 1981-82, when the pond was reduced to puddle size (with probable concentration of *tigrinum* larvae), he saw the following additional potential predators: mallard, *Anas platyrhynchos*; wood duck, *Aix sponsa*; glossy ibis, *Plegadis falcinellus*; and common egret, *Casmerodius albus*.

Ecologic Aspects of Breeding Sites

Ambystoma tigrinum breeding sites have physical parameters and community structure representative of seral stages of lentic succession. The tiger salamander appears to be a pioneer invader in some ponds as evidenced by its presence, referred to previously, in the Massey Pond

shortly after the pond appeared. Deposition of single egg masses in several small shallow man-made ponds (Westover, Somerset County; Bishopville, Worcester County; Frey Farm, Kent County) also suggest pioneer behavior. Although new ponds may be visited by *tigrinum* breeding colonies are not always established or may be established with a low density population. As succession advances the abiotic and biotic components change and the environment becomes less habitable to the aquatic phase of the *tigrinum* life cycle. Eggs, larvae and ultimately adults are affected by successional changes.

The substrate in a pond changes during succession, the pond becomes more shallow and fewer desirable sites and submerged vegetation are available for egg deposition. Additionally, dissolved oxygen diminishes, predators increase, and prey become less diverse. Golts and Massey Ponds may illustrate these changes and differences. From 1952 until 1974, when Lee and Franz (1974) collected larvae, and 1977 when Johnson observed approximately 10 egg masses (Johnson, pers. comm.) Golts Pond was a breeding site for *tigrinum*. After 1977 Golts Pond ceased to be a reproductive site. In 1952, at Golts, peripheral trees were small and few in number, the canopy was open, the water was clear and contained substantial submerged aquatic vegetation. Button bush, *Cephalanthus occidentalis* was less abundant and aquatic invertebrates appeared more abundant. Today, 32 years later, the trees around Golts Pond are larger and more numerous (Plate 19), the canopy is closing, the water is dark with tannin, there are virtually no submerged aquatics, the button bush *C. occidentalis* is much more abundant, the bottom is leaf and branch littered, aquatic invertebrates appear less numerous and diversified, aquatic predators are probably more numerous, the odor of hydrogen sulfide is present, and dissolved oxygen is lower than at Massey (Table 11). By contrast, at Massey Pond, there are fewer proximal trees, the canopy is open, the water is clear, there are submerged aquatics, the bottom is leaf and branch free, the invertebrates appear more numerous and diverse, and dissolved oxygen is higher than at Golts (Table 11).

Lee (pers. comm. Dec. 29, 1983) has an interesting hypothesis concerning successional changes at Golts and the demise of the *tigrinum* deme there. Parasitic nematodes of the genus *Hedruris* were found in larvae captured there (Lee and Franz, 1974). Aquatic snails, host of nematodes, require emergent vegetation on which to climb, breathe and lay eggs. Due to the abundance of shrubby emergent vegetation the population of snails and presumably nematodes is enhanced, increasing infestation of *tigrinum* larvae and possibly lowering recruitment numbers.

Thus, over a period of 32 years, through a combination of successional changes, we may hypothesize that fewer and fewer larvae at Golts metamorphosed reducing recruitments for breeders. Surviving adults lived out their lives until eggs were no longer deposited. Sever and

Dineen (1978) state that a high survival rate for adults and longevity (as great as 16 years) indicate a population could survive for a number of seasons without recruitment. How many years prior to 1952 that the Golts Pond was a breeding site one can only speculate - perhaps twenty years. It seems reasonable to assume that *tigrinum* is an active community member of select, semi-permanent, Maryland Coastal Plain ponds between 30-50 years if succession proceeds normally and uninterrupted.

Succession is proceeding at Massey Pond, but at a reduced rate due to a road on one side and a regularly plowed field on the other. *Sphagnum* sp. however has extended considerably inward from the pond edges from 1977 to 1983. Narrow-leaved cattail, *Typha angustifolia*, black willow *Salix nigra*, red maple, *Acer rubrum* and button bush *C. occidentalis* are also increasing, indicative of pond filling. Arnold Norden (pers. comm., Jan. 21, 1984) observed that a breeding pond of Jefferson salamander, *A. jeffersonianum* in Washington County, Maryland virtually filled within seven years following cessation of plowing of an adjacent field.

In New Jersey, Anderson et al. (1971a) found a pH range in breeding ponds of 5.6-7.0. In Indiana, Sever and Dineen (1978) found a pH of 6.8-7.0 in breeding ponds. In Massey Pond, 1982-83, the range of pH was 3.5-4.9. At Golts Pond the water is less acidic than at Massey. Data are presented in Table 12. Anderson et al. (1971a) state that low pH may have adverse effects on *tigrinum* larvae. Data in Table 12 does not confirm this assumption for Massey and suggest a greater tolerance of *tigrinum* to lower pH than previously held.

Data presented in Table 11 indicates temporal differences in the dissolved oxygen in Massey and Golts Ponds. Of particular interest is the contrast in dissolved oxygen between the two ponds in June and July, the period in which larvae are frequently transforming. Diminished oxygen, resulting from leafy decomposition at Golts, may physiologically stress larvae. Mature larvae (n=9) from 163 eggs in three masses translocated from Massey to Golts (Stine and Eng, unpublished data, 1982) had, upon capture, gills three times the length of cohorts at Massey. These enlarged gills suggests a compensatory response to low oxygen (.6 ppm) at Golts. The translocated eggs hatched without mortality in March, 1982 when water was cold and dissolved oxygen presumed high.

Table 11

Water Temperature and Dissolved Oxygen in
Massey and Golts Ponds, Kent County, Maryland

Date	H ₂ O Temp. °C	Oxygen ppm			
		Massey		Golts	
		Surface	Bottom	Surface	Bottom
3/06/82	4.5	11.8	11.7	11.2	11.0
3/13/82	14.5	10.4	9.8	-	-
4/06/82	5.0	11.8	11.8	11.4	11.4
4/30/82	21.5	10.5	-	-	-
6/11/82	20.0	6.6	-	.6	.6
7/15/82	17.0	8.2	8.0	3.6	.5
11/06/83	4.5	-	8.8	-	5.4
11/18/83	7.0	-	9.2	-	3.7
11/29/83	8.5	-	9.0	-	-
12/02/83	7.0	-	11.4	-	-
12/04/83	7.0	-	11.0	-	-
12/08/83	3.0	-	11.4	-	-
12/13/83	11.0	-	11.0	-	-
12/18/83	4.0	-	10.4	-	-
1/01/84	4.0	13.1	14.6	3.6	4.4

Adult spotted salamanders, *A. maculatum* have not been found by the author to breed in ponds with *tigrinum* in Maryland. H. Harris and R. Simmons (pers. comm., July, 1984) report having seen eggs and adults of *maculatum* in *tigrinum* ponds. I doubt that *maculatum* larvae would survive long with larger aggressive *tigrinum* larvae. Species of amphibians known to breed in *tigrinum* ponds in Maryland are the red-spotted newt, *Notophthalmus v. viridescens*; the marbled salamander *Ambystoma opacum*; the eastern spadefoot toad, *Scaphiopus holbrooki holbrooki*; Fowler's toad, *Bufo woodhousei fowleri*; northern cricket frog, *Acris crepitans crepitans*; northern spring peeper, *Hyla crucifer crucifer*; gray tree frog, *Hyla versicolor*; New Jersey chorus frog, *Pseudacris triseriata kalmi*; bull frog, *Rana catesbeiana*; green frog, *Rana clamitans melanota*; southern leopard frog, *Rana sphenoccephala* and pickerel frog, *Rana palustris*.

Table 12

pH in Massey and Golts Ponds, Kent County,
Maryland, 1982-1983

<u>Date</u>	<u>Massey</u>	<u>Golts</u>
3/13/82	4.4	-
3/21/82	4.5	5.5
4/06/82	3.6	-
4/30/82	4.9	-
6/11/82	3.8	5.0
7/15/82	4.5	5.4
11/06/83	4.3	5.5
11/18/83	4.9	4.7
11/29/83	3.6	-
12/02/83	-	-
12/04/83	4.5	-
12/08/83	3.9	-
12/13/83	3.5	-
12/18/83	3.5	-

Population Estimates

From July 1, 1976 to June 30, 1979, under a grant from the Maryland Department of Natural Resources, the author supervised a team of investigators who worked to reassess the distribution of *tigrinum* in Maryland.

Sections of the Maryland Delmarva have large numbers of ephemeral ponds in early spring (Plate 20). Some ponds lose water rapidly, while others retain water for longer periods. Utilizing Massey Pond as a model, aerial reconnaissance was conducted to map those ponds that appeared to have the ecologic pre-requisites for *tigrinum* breeding sites, i.e., isolated field ponds, field ponds adjacent to wood lots, open canopies, relative clear water, water depth not more than 3-4 feet, ponds without inlets or outlets, water retention into late May or June, in relatively early stages of vegetational succession, rich in invertebrate fauna and few predators, especially fish.

Fourteen Maryland Coastal Plain counties were surveyed. In all, 679 ponds were selected for investigation for presence of *tigrinum* eggs. The ponds were investigated shortly after eggs first appeared at Massey in late winter of 1979. It was found that the previously known sites having but one egg mass and some other ponds (Frey Farm South, Frey Farm West, Bishopville, Westover) had silted in or were destroyed by construction. Other sites were found to have been destroyed by construction (La Plata) or could not be relocated (Carson Corners, Hollingsworth, Cross Roads). Additional breeding ponds were not discovered during the search. This result however, may be falsely negative. Due to the vast number of ponds in the area some breeding sites may have been overlooked. Also, small numbers of eggs are easily missed in turbid, wind-rippled ponds. Substantiating this view, as noted previously, two reproductive sites were found in Caroline County in April and May of 1983 based on the presence of *tigrinum* larvae. Investigation for additional sites is encouraged so that population density may be monitored. Table 13 and Figure 4 detail past and present records of adults and/or eggs and/or larvae of *tigrinum*.

Population fluctuations among vertebrates are common (Southwick, 1969). Variations in population density of *tigrinum* in Maryland depend on natality, mortality of eggs and larvae, adult survivorship in relation to changes in the abiotic and biotic conditions. These variations are expressed in the total number of eggs deposited annually over a seven year period in one pond (Massey) (see Table 7).

Investigators have used different methods to calculate deme and population densities (Anderson et al., 1971a; Sever and Dineen, 1978). Anderson et al. (1971a) made assumptions regarding population estimates for *tigrinum* in New Jersey as follows: a female oviposits between 250-350 eggs, females oviposit biennially, male-female ratio is 1:1, and there are two immature non-breeders coming "on-line" presumably as replacements for breeders that die. They calculated 11,600 eggs found at a breeding site in New Jersey were laid by 33-45 females and estimated a maximum adult population of 540 individuals.

Considering the data for Massey Pond in Maryland, assumptions for populations in this state must be somewhat different. Female *tigrinum* deposit approximately 350 eggs. As noted previously, a female *tigrinum* from Golts (1954) and more recently, one from Massey (1983), deposited 344 eggs and 394 eggs respectively in the laboratory. There is evidence (1983) from marked adults at Massey Pond, that at least some males and females breed annually. Sever and Dineen (1978) state that some, if not most, female *tigrinum* breed annually in Indiana. It should be noted however, that frequency of breeding may vary seasonally and geographically. Marking studies have not supported the concept of a 1:1 sex ratio. The ratio at Massey Pond fluctuates, and in 1982 was close to four males for every female. Taken over several years (1980-83) it approaches 1.7:1.

Table 13

Distribution of the eastern tiger salamander,
Ambystoma t. tigrinum in Maryland, past and present

County	Locality	Stage	Map Key Status
		Adult(s) (A) Eggs (E) Larvae (L)	
			Former Locality 0 Current Locality ●
Anne Arundel*	Arnold	A	0
Charles	La Plata	A,E,L	0
Kent	Fred Road	L	●
	Massey		
	Frey Farm W	A,E,L	0
	Frey Farm S	A,E	0
	Road	A,E,L	●
	Golts	A,E,L	0
	Golts Garbage	A,E,L	●
	TP3	A,E,L	●
Queen Annes	Carson Corners	E	0
Caroline	Baltimore Corner	E	●
	Hollingsworth		
	Crossroads	E	0
	Denton	A	0
	Federalsburg	E	0
	Mt. Zion	L	●
	Bridgetown	L	●
Dorchester**	Vienna	A	0
Worcester	Bishopville	E	0
Somerset	Westover	E	0

*A single adult may have been introduced from the Eastern Shore.

**This site was the area from which the first Maryland specimen, an adult, was recorded. Breeding ponds or adults have not been subsequently recorded there.

Robert Shoop (pers. comm., 1984) found that the sex ratio of *A. opacum* at metamorphosis was 1:1 but that the extended maturation time for females (4-7 years) compared to that for males (1-5 years) results in greater mortality for females. As a consequence adult males outnumber adult females. Shoop also found that in "wipe out years" (drought, extended severe cold) there are few juvenile replacements for breeding adults which skews the sex ratio. These same factors undoubtedly work on *tigrinum*. For example, Sever and Dineen (1978) found the sex ratio of male to female to be 3.2:1 in 1976 and 5.1:1 in 1977 in a pond in Indiana. In contrast to assumptions made by Anderson et al. (1971a), a norm of a single juvenile replacement for each breeding adult is considered here for calculations of population estimates for *tigrinum* in Maryland. Data are presented in Table 14 comparing population estimates for selected New Jersey, Maryland and Indiana ponds and methods used to construct these estimates. Estimates for the Massey deme range from 52-216. These estimates seem appropriate in view of the number of *tigrinum* captured during breeding. Estimates for TP3 (10-23), Golts Garbage (21) and Baltimore Corner (6) are notably low suggesting marginal demes. Disparity between demes in New Jersey (540) and Massey (216) reflect differences in methods of calculation. Duellman (1954) found 296 non-breeding *tigrinum* over a five week period on land in Michigan suggesting moderate population density. Population estimates by Sever and Dineen (1978) for an Indiana deme range from 1,500-2,000 individuals.



Distribution of the eastern tiger salamander, *Ambystoma t. tigrinum* in Maryland. Shaded circles represent former localities for eggs, adult(s) and/or larva(e). Closed circles represent current breeding colonies and closed square represents Pleistocene fossil record.

Table 14
Population estimates for selected breeding ponds in
New Jersey, Maryland and Indiana

Pond Locale	Year	Est. No. ÷ Egg	No. Females 250 eggs/Female	+ Sex Ratio (1.0 males)	+ Biennial Breeding	× 2 Juvenile Replacements/ Breeder	Population Estimate	Investigators
Heisterville, NJ	1969	11,660	45	45	2 = (180)	360	540	Anderson et al. (1971)
Pond Locale	Year	Est. No. ÷ Eggs	No. Females 350 eggs/Female	+ Sex Ratio (1.7 males)	+ Annual Breeding	× 1 Juvenile Replacement/ Breeder	Population Estimate	Investigator
Massey, MD	1976-77							
Massey, MD	1977-78	3,384	9.7	16.5	0 = (26.2)	26.2	52.4	
Massey, MD	1978-79	5,750	16.4	27.9	0 = (44.3)	44.3	88.6	Stine, Johnson
Massey, MD	1979-80	7,500	21.4	36.4	0 = (57.8)	57.8	115.6	Stine, Johnson
Massey, MD	1980-81	Drought						
Massey, MD	1981-82	14,040	40.1	68.2	0 = (108.3)	108.3	216.6	Stine
Massey, MD	1982-83	4,480	12.8	21.8	0 = (34.6)	34.6	69.2	Stine
TP3, MD	1977-78	680	2.0	3.4	0 = (5.4)	5.4	10.8	Stine, Johnson
TP3, MD	1978-79	1,500	4.3	7.3	0 = (11.6)	11.6	23.2	Stine, Johnson
Colts Garbage, MD	1977-78	1,360	3.9	6.6	0 = (10.5)	10.5	21.0	Stine, Johnson
Baltimore Corner, MD	1977-78	102	1.0	1.7	0 = (3)	3.0	6.0	Stine, Johnson
Notre Dame, IN	1976-77							Sever & Dineen (1978)

Population estimates based on Peterson biostatistical method 1500-2000

Reviewing data in Table 13 and Figure 4, the following conclusions are presented:

1. The range of *A. t. tigrinum* in Maryland has been reduced from seven to five counties due to destruction of sites or successional changes (assuming that adults captured in Denton and Vienna indicated presence of breeding sites). At present, only one site, Massey Pond, has high egg production.

2. The eastern tiger salamander in Maryland is rare and its population density low. Endangered status is justified even though additional breeding sites may be found. Continued land disturbance, low population densities and successional changes suggest the need for prudent management.

Several hypotheses may be considered regarding the historic range reduction of *A. tigrinum* in Maryland.

1. Direct destruction of breeding habitat. For example the pond at La Plata, Charles County was eliminated in the construction of a golf course.

2. Indirect elimination of breeding habitat by ditching and draining of wetlands to expand agricultural land with possible lowering of water table reducing the capacity of ponds to retain water. A plan to drain the headwater swamps and channelize the upper Chester River in Kent County is presently being proposed by the Soil Conservation Service. Breeding sites of *tigrinum* are in this region.

3. Possible toxic materials (pesticides, herbicides) introduced into ponds from agricultural run-off affecting development of eggs and/or larvae. Successful hatching of eggs translocated from Massey Pond to Golts Pond suggests water quality is adequate for egg survival at Golts Pond. High egg production at Massey for six years also suggest water quality is adequate for eggs and larvae there.

4. Deforestation with possible destruction of non-breeding habitat (where aestivation and hibernation of adults may occur), introduction of toxic materials to terrestrial non-breeding habitat.

5. Acidic conditions in breeding ponds or terrestrial habitat due to acid precipitation. This hypothesis does not seem tenable in light of data presented in Tables 7 and 12 showing relatively low pH at Massey and high percentages of hatching eggs there.

6. Decreased borrow pit excavation (due to reduced road construction) and thus fewer new ponds for invasion as older ponds advance to later stages of succession. Many of the breeding sites, past and present are borrow pit ponds (Golts, Golts Garbage, Massey, Baltimore Corner).

7. Successional changes in breeding ponds including the following

- a. Abiotic changes such as decreased dissolved oxygen, altered pH, increased hydrogen sulphide, poor water clarity, lowered water depth, increased sediment, leaf and branch littered bottoms.
- b. Biotic changes such as decreased submerged aquatic vegetation for egg deposition, reduced diversity and quantity of larval prey and possibly increased predatory of eggs and larvae especially fish.

Combinations of these factors, varying with the locality, with emphasis on 1, 2, 6 and 7 probably have contributed substantially to the reduction of the range and population density of *A. t. tigrinum* in Maryland.

Van Deusen (1979) postulates that *tigrinum* is uncommon in Maryland due to isolation, low individual variation, existence at the edge of its range and low population density. The population density of *tigrinum* in Maryland is low when compared to estimates given for *tigrinum* demes in the midwest (Sever and Dineen, 1978). The Maryland density is comparable to that of New Jersey (Anderson, 1971a). Indeed through the coastal part of its range *tigrinum* appears uncommon and of low density. There may be as few as 50 known breeding sites along the east coast (D. S. Lee, pers. comm., 1984), and these have been located only through intense field work by many herpetologists. Thus, it is possible that there are limiting factors on the Coastal Plain that contribute to this low population density. I submit however, that this has been compounded by habitat alteration in Maryland. Examination of former distribution of *tigrinum* in this state suggests there was greater proximity and density of demes in the past. These demes are now more isolated (TP3 and Baltimore Corner for example, are 25 km apart, and some previously active sites were 35-50 km apart). Low density is not the cause of but is synonymous with uncommonness. Deme isolation could indeed lead to lessened gene flow and individual variation, but there is, at present, no evidence to support this. Isolation and low density are symptoms of environmental change and not the cause of uncommonness.

It is questionable whether uncommonness of *tigrinum* in Maryland is related to the state's position at the geographic edge of the species range. Coastal populations are known from Long Island, New York to Florida. To the east *tigrinum* has been recorded to within 9.6 km of the limiting salinity of a subestuary of Delaware Bay (Arndt, 1983). Thus, as suggested regarding the Maryland range, *tigrinum* had at one time, following its post Pleistocene invasion of the Coastal Plain via the prairie corridor (Holman, 1977), a relatively more dense population than now.

There is a broader geographic isolation of *tigrinum* in Maryland that is significant, that of the Maryland-Delmarva demes being isolated from the mainland by the Chesapeake Bay to the west and a narrow isthmus, with incising rivers and salt marshes to the north. This geographic isolation began 10,000 years ago during the genesis of the Chesapeake Bay (Schubel, 1981). As noted by Dunn (1926), isolation leads to speciation. It is important to continue ecological and behavioral studies of Delmarva *tigrinum* comparing it to other mid-range demes for differentiation. At least one other Delmarva amphibian, the New Jersey chorus frog, *Pseudacris triseriata kalmi* has been described as subspecific (Harper, 1955).

Translocation

In 1977, seven viable egg masses were transported from Golts Garbage and TP3 Ponds to a receptor pond at the U.S. Army installation at Edgewood, Maryland on the western shore of the Coastal Plain. A total of 22 to 37 larvae hatched and presumably dispersed (Johnson, 1980). Periodic monitoring has not revealed the presence of *tigrinum* at this site. It is believed that abundance of turtles and other possible predators at this site contributed to the failure of the translocation. The small number of egg masses and larvae that hatched were probably insufficient to insure survival of a critical number of juveniles. In August of 1979 the author recommended to the Maryland Department of Natural Resources that adequate ecologic and distributional information regarding *tigrinum* in Maryland was available to warrant management of the species. It was suggested that *tigrinum* be reintroduced to part of its former range by construction of an ecologically appropriate pond on protected state land. A pond in Charles County near the former La Plata breeding site was "seeded" with mature larvae from Massey in 1982. Monitoring will proceed for evidence of adult *tigrinum*.

Conclusions

1. Investigation of the eastern tiger salamander, *A. t. tigrinum* began in 1933 in Maryland and continues to the present. In the present *tigrinum* is found only on the Coastal Plain within the state but there are fossil records of *tigrinum* from the Appalachian Highlands dating 600,000 years ago.

2. *Ambystoma tigrinum* is the third largest salamander in Maryland. Males range from 165 mm to 240 mm in length, and 20.7 gm to 32.0 gm in weight. Female *tigrinum* range from 155 mm to 200 mm in length, and 20.6 gm to 42.0 gm in weight (Table 1).

3. In Maryland non-larval *tigrinum* appear to grow rapidly. Males have an increase in overall length ranging from 5.1-21.5% in 10-11 months. A single female increased 20.8% in 328 days. Weight increases in *tigrinum* with increase in length but some weight is lost after individuals return to breeding ponds (Table 2).

4. *Ambystoma tigrinum* breed as early as November and as late as March. Reproduction is initiated by precipitation or melting of ice and rising air temperature ranging from 4.5 to 21°C with concomitant rise of water temperatures.

5. Duration of reproductive activity ranges from 63 to 90 days.

6. In Maryland *tigrinum* apparently do not mass migrate to ponds. Some individuals may burrow from the edges into the pond during the reproductive period.

7. Reproductive congregations of *tigrinum* males and females and spermatophores in breeding ponds have been rarely observed in Maryland.

8. Female *tigrinum* assume a characteristic posture during oviposition, eggs are generally deposited on submerged aquatic vegetation, and an adult female lays approximately 350-450 eggs. Eggs take 29-33 days to hatch or longer during protracted cold weather.

9. The secondary sexual characteristics of male *tigrinum* are the keeled tail and swollen vent. Over an average of 18 days in the pond, the tail decreases an average of 0.8 mm in height and the vent 1.4 mm in width (Table 3).

10. Depth of eggs deposited by female *tigrinum* is adjusted to seasonal water depth, averaging 53 cm at Massey and 62 cm at TP3 (Table 4).

11. The number of *tigrinum* eggs per mass averages 52.

12. Female *tigrinum* loose an average of 7.3 gm in wet weight after egg deposition (Table 5).

13. Total egg deposition of a deme may take place over an extended time period, being interrupted by freezing weather. This varies annually (Table 6).

14. Total egg deposition of *tigrinum* per deme fluctuates annually, and has ranged, at Massey, from 0 (1980-1981) to 14,040 (1981-1982) (Table 7).

15. Mortality of *tigrinum* eggs in Maryland varies with the breeding location and the year. It has been as high as 70.9% at TP3 (1977) and as low as 3.9% at Massey (1978) (Table 8).

16. The number of egg masses having algae varies with the breeding location, 22.6% at TP3 and 3.8% at Massey. There appears to be a correlation between the presence of *Chlamydomonas* in eggs and mortality (Table 9).

17. Duration of larval period of *tigrinum* varies annually, ranging from 23-28 weeks, and appears dependent on water level.

18. On hatching, *tigrinum* larvae settle onto the substrate or submerged vegetation in the area of egg deposition. Later they disperse through the pond.

19. Mortality of *tigrinum* larvae in one Maryland pond (Massey) appears similar to that for ponds in New Jersey (Figure 3).

20. Prey of *tigrinum* larvae at Golts compared to Massey may reflect successional differences in the two ponds (Table 10).

21. Laboratory studies suggest a wide range of invertebrates and vertebrates prey upon *tigrinum* eggs and larvae.

22. Successional changes have occurred in *tigrinum* breeding ponds in Maryland over a period of 32 years. The tiger salamander is a community component in certain ponds from pioneer to mid-seral stage.

23. Differences in dissolved oxygen exist in Massey and Golts Ponds. Lowered oxygen may contribute to stress of larvae (Table 11).

24. Larvae at Massey occur in water having lower pH than that of ponds in New Jersey without apparent adverse effects (Table 12). The cause of the low pH is unknown but may be due to *Sphagnum* sp. invasion.

25. Population estimates for selected demes of *tigrinum* in Maryland appear theoretically similar to estimates in New Jersey but substantially less than those in the midwest.

26. The range of *tigrinum* in Maryland has been appreciably reduced the past 30 years (Table 13).

27. Population estimates for breeding *tigrinum* are estimated for several demes in Maryland to range from 6 to 216 individuals (Table 14).

28. A number of hypotheses are available to explain the range reduction of *tigrinum* in Maryland including elimination of habitat, ditching and draining, decreased pond construction and natural succession.

29. Translocation of *tigrinum* eggs to a pond in Baltimore County on the Western Shore of Maryland in 1977, to establish a breeding colony, was unsuccessful. Translocation of *tigrinum* larvae to a newly constructed pond on state land in Charles County was done in 1980. This pond is being monitored.



Plate 1. The four species of ambystomid salamanders occurring in Maryland. Clockwise, from the bottom, Jefferson salamander, *Ambystoma jeffersonianum*, immature eastern tiger salamander, *Ambystoma tigrinum tigrinum*, marbled salamander, *Ambystoma opacum* and spotted salamander, *Ambystoma maculatum*.



Plate 2. Pond at Golts, Kent County, site of the first recorded breeding adults of the eastern tiger salamander, *Ambystoma t. tigrinum* in Maryland. Photographed 1952.



Plate 3. Depression field pond, Frey Farm, Kent County, Maryland. Once an active breeding site for the eastern tiger salamander, *Ambystoma t. tigrinum*. This pond has silted in and is no longer a reproductive site. Photographed 1953.

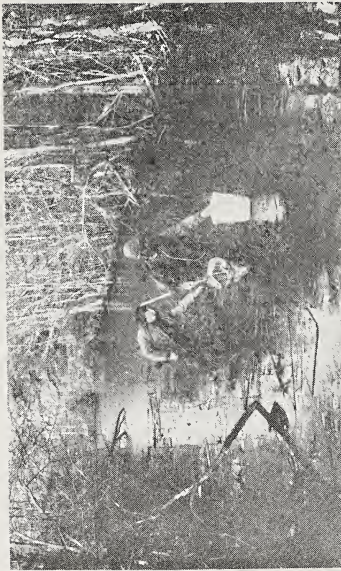


Plate 4. Gravel pit borrow pond, Baltimore Corner, Caroline County, Maryland. Situated in a secondary mixed mesophytic wood lot, this pond has been the breeding site for a marginal deme of the eastern tiger salamander, *Ambystoma t. tigrinum* since 1952. Photographed 1983.

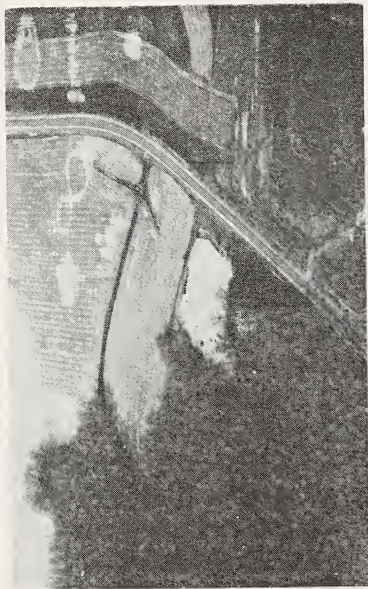


Plate 5.
Gravel pit borrow pond, Massey, Kent County, Maryland. Created in 1957 during road construction, this pond is presently the major reproductive site for the eastern tiger salamander, *Ambystoma t. tigrinum* in Maryland. Photographed 1978.



Plate 7.
TP3 Pond, Kent County, Maryland. Site of a marginal breeding deme of the eastern tiger salamander, *Ambystoma t. tigrinum*. A high percentage of egg masses in this pond contain a species of green algae, *Chlamydomonas* sp. Egg mortality is higher here than at Massey Pond (See Tables 7 & 8). Photographed 1978.

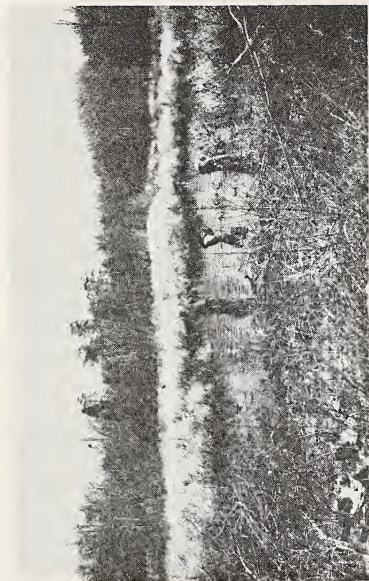


Plate 6.
Golts Garbage Pond, Kent County, Maryland, site of a small deme of the eastern tiger salamander, *Ambystoma t. tigrinum*. Note the button bush, *Cephalanthus occidentalis* crowding the open water as a vegetative component of advancing succession. Photographed 1978.



Plate 8.
A post-reproductive male eastern tiger salamander, *Ambystoma t. tigrinum* from Massey Pond, Kent County, Maryland. Total length 180 mm, weight 31.8 gm. Photographed 1953.



Dorsal view of female eastern tiger salamander, *Ambystoma t. tigrinum* with eggs from Massey, Kent County, Maryland. Note roundness of abdominal region. Photographed 1984.

Plate 10.



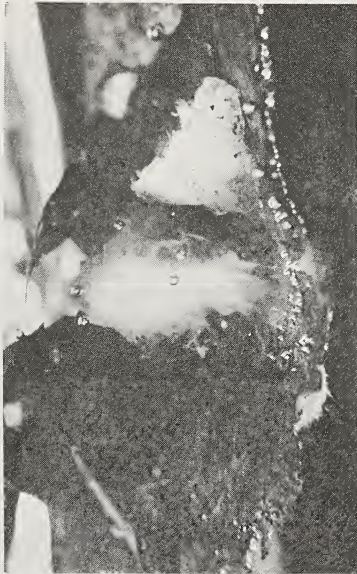
Captive female eastern tiger salamander, *Ambystoma t. tigrinum* from Massey, Kent County, Maryland ovipositing. Photographed 1953.

Plate 12.



Ventral surfaces, showing cloacal regions of adult breeding female (left) and male (right) eastern tiger salamanders, *Ambystoma t. tigrinum* from Massey Pond, Kent County, Maryland. Note swollen cloaca of male. Photographed 1984.

Plate 9.



Spermatophores (8 mm high) of the male eastern tiger salamander, *Ambystoma t. tigrinum* from Golts Pond, Kent County, Maryland. Left, lateral view. Right front view. Photographed 1953.

Plate 11.

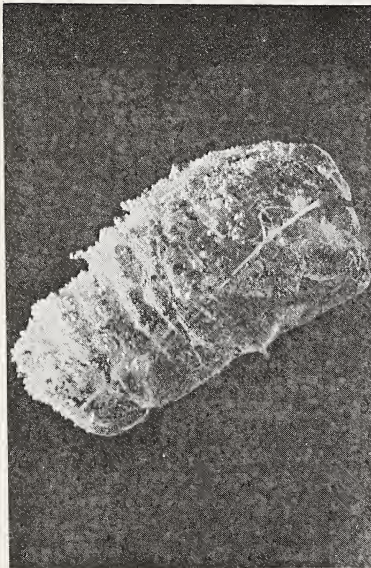


Plate 13. Egg mass of eastern tiger salamander, *Ambystoma t. tigrinum* from Massey Pond, Kent County, Maryland. Eggs, here deposited on panic grass, *Panicum aristoides*, are hygroscopic. Their volume increases rapidly after deposition. Photographed 1955.



Plate 14. Eggs of the eastern tiger salamander, *Ambystoma t. tigrinum* are serous, slipping through fingers, upon attempted removal from the water. This feature is useful in differentiating eggs of *tigrinum* from those of spotted salamander, *A. maculatum* in the field. *Ambystoma maculatum* and *A. t. tigrinum* have not been found to breed in the same ponds in Maryland. Photographed 1956.

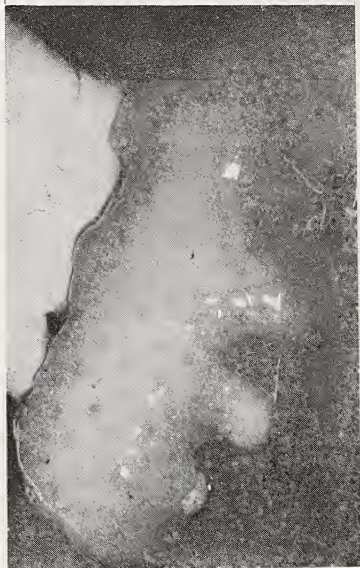


Plate 15. Eggs of the spotted salamander, *Ambystoma maculatum* are more compact than those of *tigrinum* and may be removed from the water entirely. Photographed 1956.

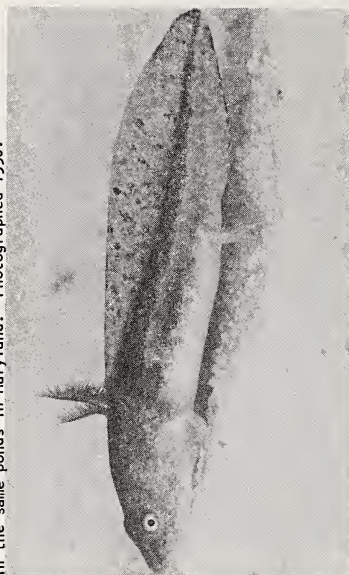


Plate 16. Lateral view of mature larva of the eastern tiger salamander, *Ambystoma t. tigrinum* from Massey Pond, Kent County, Maryland. Note strongly keeled tail and filamentous gills. Photographed 1953.



Plate 18. Predation of immature eastern tiger salamander larva, *Ambystoma t. tigrinum* by mature marbled salamander larva, *A. opacum* in the laboratory. Photographed 1953.



Plate 20. Aerial view, looking east from Massey Pond, Kent County, Maryland, showing the large number of ephemeral ponds dotting the landscape in late winter and early spring. Few, if any, of these ponds are used for breeding by the eastern salamander, *Ambystoma t. tigrinum*. Photographed 1978.



Plate 17. Front view of the mature larva of the eastern tiger salamander, *Ambystoma t. tigrinum* from Massey Pond, Kent County, Maryland. Note broad flat head and filamentous gills. Photographed 1953.



Plate 19. Golts Pond, Kent County, Maryland. Photographed from same vantage point as that in Plate 2 showing increase in size and number of peripheral trees as a component of succession. Photographed 1984.

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Figure 1 map is adapted from A Field Guide to Reptiles and Amphibians of Eastern and Central America by Roger Conant. Copyright 1958, 1975 by Roger Conant. Reprinted by permission of Houghton Mifflin Company.

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Baltimore, Maryland 21205*

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SYSTEMATIC STATUS OF THE SOUTH AMERICAN FROG
"*Phylllobates mandelorum*" (AMPHIBIA, DENDROBATIDAE)

Schmidt (1932), in his description of "*Phylllobates mandelorum*", compared this species to *Phylllobates* [= *Colostethus*] *trinitatis*, pointing out that, in *mandelorum*, the dark pectoral bar (characteristic of *trinitatis*) was completely absent. Rivero (1961, 1964) regarded *mandelorum* as a subspecies of *Prostherapis* [= *Colostethus*] *trinitatis*, basing his conclusion on the fact that in some of the cotypes of *Prostherapis trinitatis* the intensity of the pectoral bar was greatly reduced, thus approaching the condition seen in *mandelorum*. Edwards (1971) placed *mandelorum* in the genus *Colostethus*, but added no new information on its taxonomic status.

There are two morphological characters and one pigmentary character (in addition to the absence of a pectoral bar) which separate *Colostethus trinitatis mandelorum* (fide Rivero, 1961) from typical *Colostethus trinitatis*. In *Colostethus trinitatis* there are no dermal fringes on the toes, and webbing is absent between the first and second toes (Hardy, 1983); whereas, in *Colostethus mandelorum* webbing is present between all of the toes, and dermal fringes are well-developed (Figure 1a, b). In typical *trinitatis* the edge of the upper jaw is immaculate or randomly variegated, while in *mandelorum* there is a well-developed dark stripe along the upper jaw which terminates posteriorly in a conspicuous pigment blotch extending upward toward the eye (Figure 1c, d).

On the basis of these characters, and in spite of the fact that on Trinidad (to which the range of *trinitatis* may be limited) *Colostethus trinitatis* sometimes has the pectoral bar greatly reduced, it is evident that *Colostethus mandelorum* is a distinct species. Its relationship to other members of the genus *Colostethus* will not be well understood, however, until additional specimens are collected.

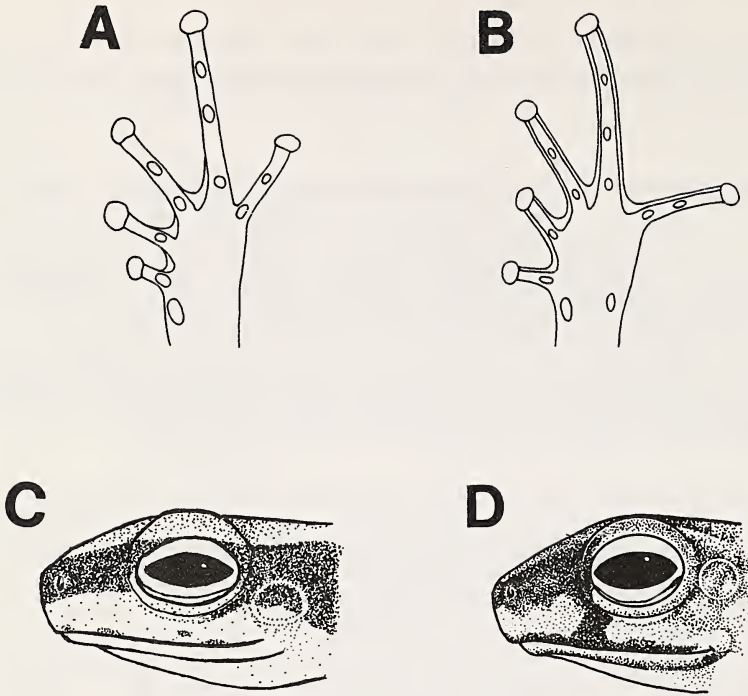


Figure 1. Toe morphology and jaw pigment in *Colostethus trinitatis* and *Colostethus mandelorum*.
A. Foot of *C. trinitatis*; B. Foot of *C. mandelorum*; C. Side view of head, *C. trinitatis*;
D. Side view of head, *C. mandelorum*.

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—Jerry D. Hardy, Jr., *Natural History Society of Maryland*,
2643 N. Charles Street, Baltimore, Maryland 21218

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RANGE EXTENSIONS OF *Kinosternon acutum* AND
Rhinoclemmys areolata IN VERACRUZ, MEXICO.
(TESTUDINES: CRYPTODIRA)

In a previous account (checklist) dealing with some aspects on the distribution of the freshwater turtles of Veracruz (Pérez-Higareda, 1978), information was given for the species *Kinosternon acutum* and *Rhinoclemmys areolata*. In 1979, Smith and Smith, provided more detailed information on the distribution of these species. New records of the distribution of these two species are reported here, to provide a more accurate distributional account of them.

Kinosternon acutum Gray

Even though the distribution is widely known from central Veracruz southward in lowlands to northern Guatemala, through the States of Tabasco, Campeche, Oaxaca, Chiapas and Quintana Roo, not including Yucatán (Smith and Smith, *loc. cit.*), this is a rare species of freshwater turtle and, few specimens exist in collections. The most southern known locality in Veracruz corresponds to the region of Los Tuxtlas (Laguna Escondida) in the Municipality of San Andrés Tuxtla, Veracruz (Pérez-Higareda, *loc. cit.*). In December, 1983, one specimen was collected by myself in the west bank of the Tonalá River, border between Veracruz and Tabasco, in the locality named "Los Soldados", Municipality of Agua Dulce, Veracruz, in the extreme southern portion of the State, specimen 1945 (field 83400) in the herpetological collection of the Estación de Biología "Los Tuxtlas", U.N.A.M.

Rhinoclemmys areolata (Duméril and Bibron)

This terrestrial species is known from central Veracruz to northern Guatemala, including the States of Tabasco, Campeche, Oaxaca, Chiapas, Quintana Roo and Yucatán (Smith and Smith, *loc. cit.*). Five specimens were collected in the -- previously mentioned locality. The specimens were found not on land, but swimming under water; this is not at all unusual in these terrestrial species. The occurrence of this species on the west bank of the Tonalá River, represents the northernmost known locality in Tabasco. Live specimens (field 83402-83405).

Both of these records are important range extensions for the freshwater turtle fauna of the state of Veracruz.

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—Gonzalo Pérez-Higareda, *Estación de Biología Tropical "Los Tuxtlas"*, Instituto - de Biología, Universidad Nacional Autónoma de México, Apartado Postal 51, Catemaco, Veracruz, México

Received: 6 June 1984

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NEWS AND NOTES:

BOOK REVIEW:

THE T.F.H. BOOK OF SNAKES. By Thomas Leetz. T.F.H. Publications, 211 West Sylvania Avenue, Neptune City, New Jersey, 07753. 77 pp., 95 figs (all in color), 8½ x 11 in., hardbound. \$7.98. 1983.

The unusually large page size of this book serves the laudable purpose of displaying to maximum advantage the excellence of the color photography--certainly some of the best ever published of snakes. Especially notable is the superb technical and aesthetic mastery evident in Ken Lucas' 28 photographs, most of which are reproduced at the large size that they deserve. They document perhaps the finest snake photography produced in this country, with sharp focus throughout the subject, appealing pose and background, rich color, luminosity, bright illumination and maximum close-up view. The portrayals are far better than "reality," as seen with one's own eyes. They firmly establish Lucas among the very top snake photographers of the world.

Many of the other illustrations, from numerous sources, are very good, some excellent. In conjunction with the high quality paper, large format, the sound, readable and informative text, and bold type, they combine to constitute a professional masterpiece without equal, of its genre.

Because the book is about snakes in general, species from all over the world, both poisonous and non-poisonous, are illustrated, although most are native to North America. Photos of exotic species are adroitly integrated with the text.

The discussion is directed toward beginners, starting with "Serpent Politics," an excellent discourse on proper attitudes toward snakes at every level: before obtaining any, acquiring them, and caring for them. The characteristics and specializations of snakes, the criteria for selection of a captive, and the hazards of poisonous species are reviewed. Various essentials of care, feeding, breeding and illnesses are discussed, then the family classification of snakes. The boas, pythons and their relatives are treated in some detail, and colubrid snakes are given somewhat less space. No other groups are discussed in detail.

The role of this book is that of an eye-opener. It presents the subject of snakes in the most broadly appealing way, visually and conceptually. Those who are intrigued by that appeal will have to satisfy their desire for further information with any of several semi-technical

books; most other popular "introductions" to snakes, of which there are many, cover much the same ground, although Leetz provides a uniquely sensible, mature philosophy of ophidian husbandry for the amateur. A truly popular modern Encyclopedia of Snakes, comparable in scope and depth to Pritchard's Encyclopedia of Turtles, is yet to appear.

But for an introduction to the subject, this book has no peer despite the abundance of competition.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, Box 334, Boulder, Colorado 80309*

Received: 30 June 1984

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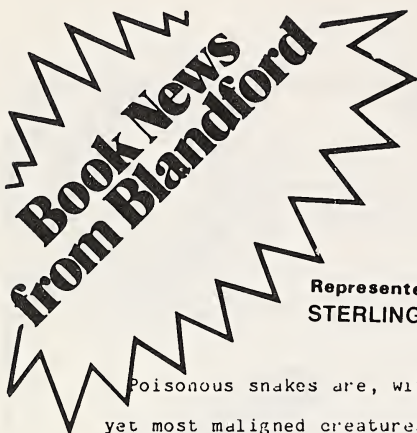
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NEWS AND NOTES:



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Tony Phelps captured his first adder at age 8. He has since studied snakes in England, Africa, Southeast Asia, South America and the U.S.A.

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Fourteen miles off the coast of Belize (British Honduras) along the coral barrier reef lies a small uninhabited 1 - 2 acre island known as Wee Wee Caye. Buttonwood, mangroves and coconuts are the principle vegetation types on this tiny island. As far as we know there are no mammals and very few transient birds on the island. The island is however covered with boa constrictors of all sizes. We would like some volunteers to help us this summer collect, mark, release, photograph and study this large population of boas. It is not uncommon to locate 10 or more snakes within 20 minutes. ZRI is interested in finding out how such a small island can support such a large population of snakes.

Also in the southern part of Belize lies a belt of very dense tropical rain forest, which herpetologically speaking is virtually unknown. Every time we have visited this area we have turned up new species and range extensions. ZRI is interested in cataloging and photographing herps from this area for future publication and we need your help. Conservation is of prime importance and no large collections are to be made.

International Zoological Expeditions will be conducting this study for the Zoological Research Institute.

Prerequisites - anyone in good physical health who has an interest in the study of reptiles and amphibians.

Costs - Approximate costs for vehicles, boats, lodges, hotels, gas meals, etc. will be about \$ 550.00 per volunteer. Since space will be limited a \$200.00 non refundable deposit is necessary. We will coordinate your flight arrangements.

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AUTUMN ESHL MEETING AT RUTGERS UNIVERSITY

The Eastern Seaboard Herpetological League (ESHL) will hold its autumn biannual meeting on Saturday, 20 October, at Rutgers University in Newark, New Jersey. The ESHL is a consortium of 13 regional herpetological societies (Massachusetts, Connecticut, New York, Philadelphia, Washington, Western Massachusetts, Maryland, Association for the Conservation of Turtles and Tortoises, NOAH, Georgia, Lehigh Valley, Virginia, and Turtle Trust); twice a year (March and October) meetings are held during which lectures on a variety of herpetological topics are presented. All members of any of the constituent societies are invited to attend the meetings. There is no registration fee.

Three speakers have been confirmed for the Rutgers meeting, sponsored by the New York Herpetological Society and Dan Wilhoft. These are:

Dr. William S. Brown, Department of Biology, Skidmore College. "The Timber Rattlesnake: Natural History of a Threatened Species in New York."

Dr. Herndon Dowling, Department of Biology, New York University. "New Ideas on Snake Phylogeny."

Dr. Paul Maderson, Department of Biology, Brooklyn College. "The Squamate Epidermis."

In addition to these (and perhaps one or two more) presentations, there will be a "panel discussion" on a herpetological topic (to be decided on).

The meeting will be held in Room 100 of Boyden Hall, Rutgers University. The University is in Newark; the exit from I-280 (go west from the New Jersey Turnpike or east from the Garden State Parkway) is clearly marked and the university is just a few blocks from I-280. There are many motels and restaurants within walking distance of the university; people planning to stay overnight may be able to find accommodations in the homes of local NJ or NY ESHL members; call the meeting coordinator for further information on this (Dave Hulmes, 201/427-0768).

Registration will begin about 11:00 on Saturday morning, 20 October and the first paper will begin at noon. The meeting will conclude about 6:00 PM.

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The Society also publishes a Newsletter on a somewhat irregular basis. These are distributed to the membership free of charge. Also published are Maryland Herpetofauna Leaflets and these are available at \$.25/page.

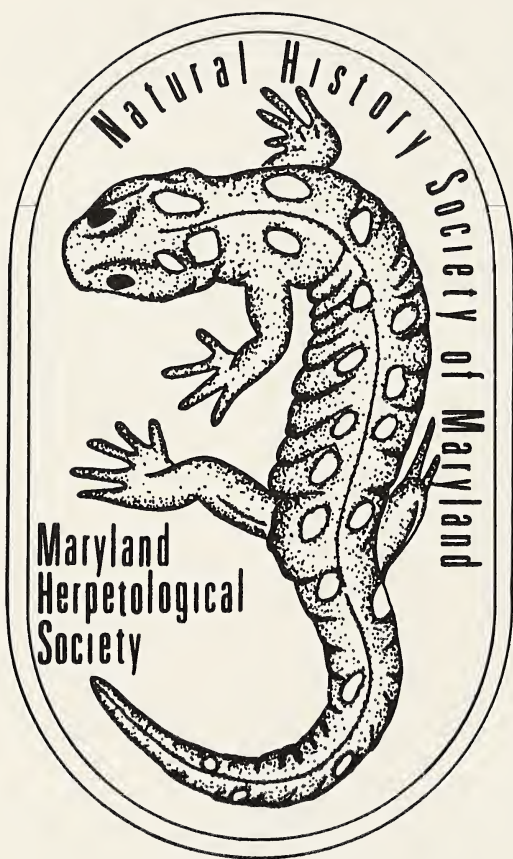
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Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

ON SOME ASPECTS OF THE HISTOCHEMISTRY OF THE
ALIMENTARY CANAL OF THE TERRAPIN,
Mauremys caspica (GMELIN)
(REPTILIA, Testudines, Emydidae)

Noory T. Taib

Abstract

The distribution and localization of carbohydrates, lipids, nucleic acids, proteins and nine digestive enzymes in the epithelium of the alimentary canal of *Mauremys caspica* were studied. The histochemical reactions revealed the occurrence with variation of numerous active secretions of mucosubstances and digestive enzymes. These findings are discussed in the context of its feeding habits.

Introduction

Mauremys caspica (Gmelin), the strip-necked terrapin inhabits both fresh and brackish water and occurs in northeast Saudi Arabia and several other countries of the Arabian Gulf (Loveridge, 1955).

A survey of the literature revealed that little histochemical work has so far been carried out on the alimentary canal of reptiles (Wright et al., 1957; Anwar and Mahmoud, 1975; Chou, 1977; Taib, 1981; Suganuma et al., 1981; Taib and Jarrar, 1983) and no histochemical work had been undertaken on the alimentary canal of *Mauremys caspica*.

The morphology and histology of the alimentary canal of *Mauremys caspica* were described in an earlier paper (Taib and Jarrar, 1982). The present study is an attempt at understanding the digestive physiology of this species in relation to the epithelium secretions of its alimentary canal.

Materials and Methods

Ten adult *Mauremys caspica* were used in the present study. Each animal was anaesthetized with chloroform and the following parts of the alimentary canal were identified, flushed of and isolated, namely, upper oesophagus, lower oesophagus, stomach (cardia and pylorus), small

intestine, colon, and rectum. Paraffin as well as unfixed fresh cryostat sections (5-12 μm at -25°C) were routinely used. A tabulated outline of the histochemical methods employed is given in Table I. The control in each case consisted of parallel incubation of sections in media lacking a specific substance or using heat-incubating sections. Visual estimation of the dye deposited in different regions using light microscopy examination was used as a measure of the relative activity of the enzymes and presence of other compounds (Figures 1-12).

Table I

List of Histochemical Tests Undertaken

<u>Test or Technique</u>	<u>Reference</u>
1. Best's carmine	Best (1906)
2. Periodic acid-Schiff (PAS)	Gurr (1962)
3. Diastase treatment (one hour at 37°C , Subsequently stained with PAS)	McManus and Mowry (1964)
4. Alcian blue pH 2.5	Mowry (1956)
5. Alcian blue pH 1.0	Mowry (1956)
6. Alcian blue pH 2.5/PAS	Mowry and Winkler (1956)
7. Alcian blue pH 1.0/PAS	Mowry and Winkler (1956)
8. Osmium tetroxide	Mallory (1961)
9. Sudan Black B	Chiffelle & Putt (1951)
10. Ninhydrin-schiff	Yasuma and Ichikama (1953)
11. Mercuric Bromphenol blue	Pearse (1972)
12. Toluidine blue	Pearse (1972)
13. Acid phosphatase	Pearse (1972)
14. Alkaline phosphatase	Gomori (1952)
15. Lipase	Gomori (1952)
16. Nonspecific esterases	Gomori (1952)
17. Exopeptidase	McCobe and Chayen (1965)
18. Endopeptidase	Yamada and Ofugi (1968)
19. Beta-glucuronidase	Hyashi et al. (1964)
20. Carbonic anhydrase	Haüsler (1958)



Figure 1 - Stomach. Periodic acid-schiff, X90.

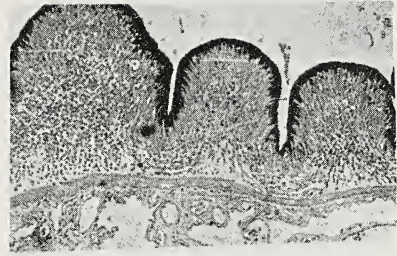


Figure 2 - Colon. Alcian blue pH 2.5, X90.



Figure 3 - Oesophagus. Toluidine blue, X120.

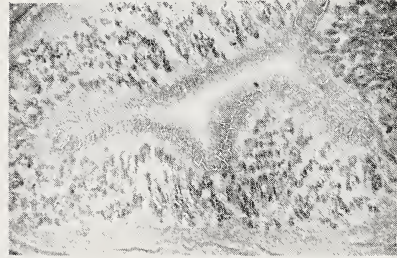


Figure 4 - Stomach. Mercuric bromophenol blue, X90.

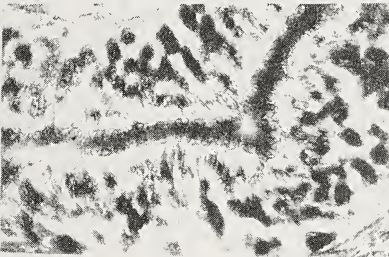


Figure 5 - Stomach. Osmium tetroxide method for lipids, X120.

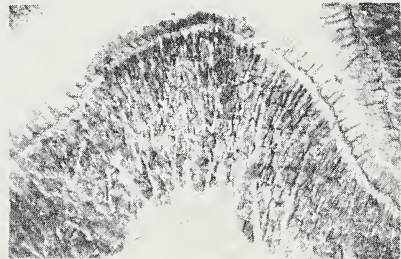


Figure 6 - Stomach. Sudan Black B, X90.

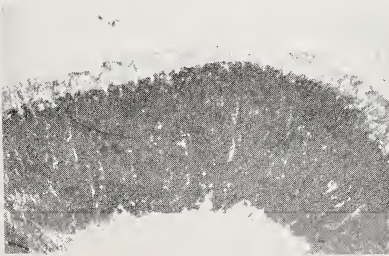


Figure 7 - Stomach. Lead nitrate method for acid phosphatase, X90.

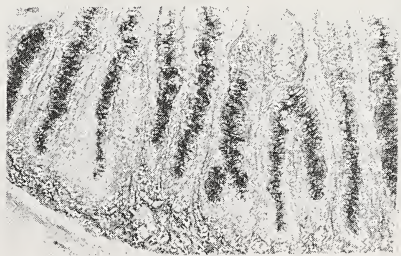


Figure 8 - Duodenum. Calcium-cobalt method for alkaline phosphatase, X90.

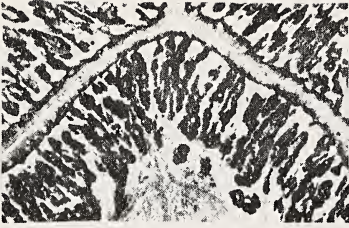


Figure 9 - Stomach. The α -naphthol acetate method for nonspecific esterase, X90.



Figure 10 - Duodenum. McCabe and Chayen method for aminopeptidase, X90.

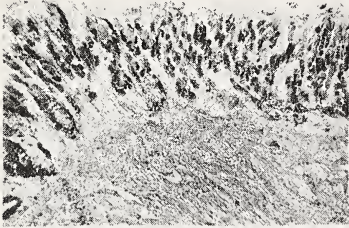


Figure 11 - Stomach. Häusler method for carbonic anhydrase, X90.

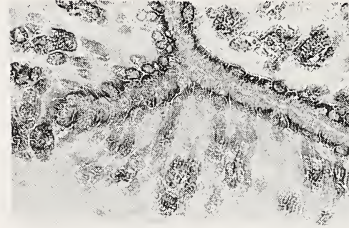


Figure 12 - Stomach. Naphthol AS-BI Glucuronide method for β -glucuronidase, X120.

RESULTS

The histological structure of the alimentary canal of *Mauremys caspica* has been described by Taib and Jarrar (1982). Accordingly, the oesophagus is lined with ciliated columnar and goblet cells and is without oesophageal glands. The surface epithelium of the stomach is of a single layer of columnar mucous cells with occasional goblet cells. The lining of the gastric glands consists of epithelial cells interspersed by mucous cells. The lining of the intestine is made up of both striated columnar and goblet cells. Throughout the intestines, goblet cells predominate posteriorly.

The result of these histochemical experiments carried out in this study are given in Table II.

Carbohydrates:

The lining epithelium of the oesophagus reacted strongly with carbohydrate-staining sequences. The results indicated the presence of neutral polysaccharides as well as sialomucins and sulfomucins. The lower oesophagus showed a prominent of sulfomucins while in the upper oesophagus, the amount of sulfomucins and sialomucins were almost equal. The apical surface of the ciliated columnar cells also stained for sialomucins. The covering epithelium of the stomach displayed abundant polysaccharides and little sialomucins and sulfomucins. Gastric glands were stained brightly with PAS. On treatment with diastase, a certain amount of PAS-positive material was removed from the gastric glands but the stomach lining remained unaffected.

TABLE II

Results of Histochemical Reactions on the Lining Epithelium
of the Alimentary Canal of *Mauremys caspica*.

	*1	2	3	4	5	6	7	8	9
Periodic acid-Schiff	+++	++	+++	+++	+	++	++	+++	+++
Diastase digestion	-	-	-	-	+	-	-	-	-
Best's carmine	?	+	-	-	+	-	-	-	-
Alcian blue pH 2.5	++	+++	++	++	+	+	++	++	++
Alcian blue pH 1.0	+++	+++	++	++	+	+	++	++	+++
Ninhydrin-Schiff	++	++	+	+	++	+	+	+	+
Mercuric Bromophenol blue	+	+	+	+	+++	+	+	++	++
Toluidine blue	++	++	++	++	++	+	+	++	++
Sudan Black B	+	+	+	+	++	+	+	+	+
Osmium tetroxide	±	±	±	±	++	+	±	+	+
Acid phosphatase	-	+	+	+	+++	+	±	-	-
Alkaline phosphatase	±	+	?	?	+	+	±	±	±
Nonspecific esterases	+	+	-	-	+++	++	++	++	++
Lipases	-	-	-	-	?	-	-	-	-
Aminopeptidase	±	±	+	+	+	++	+	±	±
Endopeptidase	-	±	±	±	±	+	±	-	-
Carbonic-anyhydrase	±	+	?	?	++	+	+	±	-
Beta-glucuronidase	±	+	-	-	+	++	++	±	-

*Key: 1. Upper oesophagus; 2. Lower oesophagus; 3. Cardia; 4. Pylorus; 5. Gastric glands; 6. Anterior small intestine; 7. Posterior small intestine; 8. Colon; 9. Rectum.
 **Code of reaction: -, absent; ±, very weak; +, weak; ++, moderate; +++, strong; +++, very strong; ?, uncertain.

In the intestine, the striated border of columnar cells and their basement membrane stained positively for neutral polysaccharides and sulfomucins. Goblet cells throughout the intestine contained neutral and acidic polysaccharides. However, unlike the goblet cells in the small intestine, those in the large intestine showed more intensive stain for sulfomucins. A predominant pattern of sialomucins in the goblet cells of the crypts of the intestine epithelium was also observed.

Proteins:

The lining epithelium of all regions of the alimentary canal gave positive reactions for proteins. The apical cytoplasm of the ciliated columnar cells of the oesophagus demonstrated the most pronounced staining. Gastric glands reacted strongly indicating the presence of a considerable amount of stored or enzymatic proteins. Globules of goblet cells showed faint β -metachromasia with toluidine blue, while their cytoplasmic granules gave strong β -metachromasia reaction, indicating that the proteins were either glyco- or muco-proteins. The nuclei of all cells lining the alimentary canal were positively stained for proteins.

Lipids:

Most of the lipids were found in the cells lining the stomach, the gastric glands and the large intestine. Lesser quantities were detected in the oesophagus and in the large intestine. In the epithelial cells, lipid globules appeared to be concentrated in the basal region of the cytoplasm while their basal border as well as cells coat were densely packed with heavily staining globules. Goblet cells throughout the entire alimentary canal displayed a negative reaction for lipids.

Phosphatases:

A pronounced but diffuse cytoplasmic reaction of acid phosphatase was obtained in most of the cells lining the gastric glands. On the other hand, the cells lining the stomach showed only weak activity while a slighter reaction of acid phosphatase activity was noticed in the striated borders of the columnar cells lining the small intestine. Here, the reaction occasionally extended well into the distal half of the cell.

Alkaline phosphatase demonstrated a moderately positive reaction in the gastric glands and the columnar cells lining the small intestine, but only slight activity of this enzyme was observed in the lining of the lower oesophagus and the anterior portion of the large intestine. However, the activity of alkaline phosphatase was less than that of acid phosphatase. Phosphatases are enzymes of lysosomal origin (Bowen, 1968) and are found in high concentration in the cells which are active in secretion (Reid, 1966). It is recognized that phosphatases are involved in supplying the energy required for the active process of secretion (Taib, 1976), and the

absorption in the duodenum in various rodents (Hugon and Borgers, 1968). The activity of alkaline phosphatase in the lining of the small intestine indicates a role in absorption of material from the lumen of the gut.

Lipolytic activity:

Nonspecific esterases activity was detected in the lining of all regions of the alimentary canal. The most pronounced reaction was also observed in the gastric glands. A pronounced reaction was also observed in the lining epithelium of the intestines with a gradual diminution of activity posteriorly. A low level of activity was recorded in the oesophageal lining. The goblet cells as well as the mucous-secreting portion of the cells lining the stomach showed no evidence of any esterase activity. Esterase activity has been demonstrated in both lysosomes and microsomes by biochemical and cytochemical techniques (Holt, 1963; Tappel, 1969).

Gomori's Tween method failed to reveal any lipase activity anywhere in the alimentary canal, although the validity of the method was successfully tested with sections of the pancreas. The failure to locate any lipase activity is probably due to its weakness or complete absence. It is probable that the unsaturated substrate (Tween 80) is attacked only by pancreatic lipase and not by other esterases. However, the Tween method for demonstration of lipases has not generally proved to be sufficiently sensitive unless the animals are maintained on a high fat-content diet (Jennings, 1962).

Proteolytic activity:

The lining epithelium of the small intestine gave an extremely strong and vivid reaction for aminopeptidase with gradual diminution posteriorly. Considerable activity was also recorded in the gastric glands. The lining of the lower oesophagus, however, showed a faint positive reaction. The activity was almost absent in the large intestinal epithelium.

Endopeptidase activity was moderately positive in the lining epithelium of the small intestine while a low activity was observed in the lining of the oesophagus, stomach, and gastric glands. In the large intestine the activity became noticeably almost negligible. It may be that these enzymes are probably concerned with the later stages of digestion and absorption of material from the gut lumen (Taib, 1976). Proteolytic enzymes have been recognized to be always present in the cells lining the gut. These enzymes when intracellular, are normally in an active state, often requiring partial digestion for activation (Smith, 1960).

Carbonic anhydrase:

Intensive activity of carbonic anhydrase appeared in some cells lining the gastric glands. Considerable activity was observed in the lining of the lower oesophagus and the anterior part of the small intestine, but was found to be weak in the lining of the large intestine. Carbonic anhydrase is so far known to occur in an active condition and that it was associated with production of hydrochloric acid in the stomach (Jennings, 1962; Taib, 1981). This may perhaps explain the appearance of the intense reaction in the gastric glands which are known to be the source of gastric hydrochloric acid.

β -glucuronidase:

Strong activity of β -glucuronidase was indicated in the lining epithelium of the small intestine and it was localized in the distal parts of the cells. Some cells lining the gastric glands demonstrated moderate activity. A low level of β -glucuronidase activity was detected in the apical surface of the ciliated columnar cells of the lower oesophagus. The activity in the lining of the large intestine was almost negligible. β -glucuronidase is important in hydrolysing oligosaccharides and is known to occur in lysosomes (Novikoff, 1961), and in other parts of certain cells (Rosenbaum and Ditzion, 1963).

Discussion

The result of this study showed that neutral mucosubstances are evident in the stomach while acidic mucosubstances occur in the oesophagus and the intestine. Sialomucins were most prominent in the lower oesophagus and sulfomucins in the large intestine. I may, therefore, postulate that acid mucosubstances may play some protective role against gastric reflux and aid in faecal discharge. The abundance of acid mucosubstances in the oesophagus of this species is, however, little understood since this terrapin usually feeds under water and it may take a large quantity of water to facilitate swallowing and no need of mucosubstances secretion to be involved in this function. This pattern of mucosubstances distribution in the alimentary canal resembles that which occurs in several other reptiles such as the skink, *Eumeces latiscutatus*, the turtle, *Glemmys japonica*, the gecko, *Gehyra multilata*, and the snake *Elaphe climacophora* (Chou, 1977; Suganuma et al., 1981). Epithelial mucosubstances occur both as intracellular components as well as extra cellular luminal secretions. Mucosubstances are believed to occur as glycoproteins when secreted into the gastrointestinal lumen (Kent, 1971).

The diet of *Mauremys caspica* is varied (Mahmoud and Klicka, 1979), containing plant material, insects, small invertebrates and amphipods. The feeding habits of this terrapin vary with the age of the animal and the seasons. The change in the dietary requirements with age being

partially related to their physiological demands. Juvenile terrapins have been observed to feed on small insects with a high calcium content which is necessary for shell growth (Mahmoud and Klicka, 1979). This terrapin feeds mainly on insects during early summer and with the decline in the insect population in late summer, it feeds more on plants. The result of this study shows that *Mauremys caspica* possesses an enzyme complement capable of breaking down a varied diet. The results also suggest that the considerable amounts of various enzymes in its stomach and the small intestine help to ensure the maximum utilization of the food ingested.

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EFFECTS OF RATTLESNAKE (*Crotalus viridis oreganus*)
ENVENOMATION UPON MOBILITY OF MALE WILD
AND LABORATORY MICE (*Mus musculus*)

Abstract

After envenomation by adult rattlesnakes (*Crotalus viridis oreganus*), male wild mice (*Mus musculus*) were found to travel significantly farther than male laboratory mice (*M. musculus*) in an open field prior to immobilization (\bar{x} = 462 and 206 cm, respectively; range = 0-940 cm). The inequality was attributed to differences in mobility since wild control mice traveled farther during three minutes in an open field than laboratory control mice (\bar{x} = 1702 and 975 cm, respectively), and latency to immobilization was the same (\bar{x} = 56 sec). Because wild *Mus* are probably representative of natural prey items, further assessment of rattlesnake prey trailing ability should include trails of at least 480-500 cm to have ecological validity.

Rattlesnakes often rely on an ambush strategy for feeding on rodent prey (Chiszar et al., 1981; Klauber, 1972). Prior to a strike potential prey are detected mostly by visual and thermal cues (Chiszar & Radcliffe, 1976; Klauber, 1972). After striking, adult rodent prey are usually released to prevent damage from rodent teeth and claws, but smaller, less dangerous prey are often not released (Kardong, 1982; O'Connell et al., 1982; Radcliffe et al., 1980). Furthermore, rattlesnakes typically do not begin to search for rodent prey until several minutes after a successful strike (Chiszar et al., 1977), apparently to avoid encountering wounded prey still capable of defensive actions (Estep et al., 1981). In an escape response the rodent often wanders several meters before immobilization and death. The snake then locates its dead prey by strike-induced chemosensory searching (SICS), characterized by a sustained high tongue-flick rate (see Chiszar & Scudder, 1980, and Chiszar et al., 1982, for reviews). Associated with lateral head movements, SICS allows the snake to contact and follow the chemical trail of the envenomated rodent (Dullemeijer, 1961; Golan et al., 1982) which, when located, may be distinguished from a nonenvenomated carcass (Chiszar et al., 1980; Duvall et al., 1978, 1980).

Previous studies have demonstrated rattlesnake ability to locate envenomated prey (Dullemeijer, 1961; Golan et al., 1982), but all experiments involving this trailing phenomenon have used the laboratory mouse (*Mus musculus*). Adequate models of the natural situation would be desirable so that experimental results would better reflect natural predatory behavior. Information concerning prey travel distance after envenomation, necessary for assessing rattlesnake trailing ability, has been provided for the laboratory mouse (Estep et al., 1981), but not for

natural prey items. Assuming wild mice (*M. musculus*) are representative of natural prey, the objectives of this study were 1) to determine travel distance of wild mice after envenomation, and 2) to compare travel distance following envenomation of wild mice in this study with laboratory mice and data from previous studies. Since wild mice appear to run faster than laboratory mice, it was hypothesized that wild mice travel substantially farther than laboratory mice after a successful strike. If so, this investigation would indicate that the trailing task confronted by rattlesnakes under natural conditions is greater than previously believed (Estep et al., 1981).

Materials and Methods

Eight adult northern Pacific rattlesnakes (*Crotalus viridis oreganus*) captured during April 1983 in Walla Walla County, Washington, were maintained collectively in a large (165 x 87 x 86 cm) indoor pen with paper floor coverings, several rocks, and a glass vessel filled with water. All had refused food during semihibernation (16-20°C) for three months at an LD 12:12 photoregime. One week prior to start of experimentation the temperature was increased by an electric heater to 25-30°C to induce feeding (Klauber, 1972).

Only adult male mice were used in this study to avoid potential sexual differences in mobility (Estep et al., 1981) and venom resistance (Russell, 1980). Male laboratory mice exhibit a greater capacity for each of these measures. Wild mice (*Mus musculus*) were captured from a local barn.

Experimental procedures were patterned after a similar study by Estep et al., (1981) and conducted during January and February, 1984. Snakes were individually placed within a 38-liter aquarium and allowed at least 30 min. adjustment prior to experimentation. Control mice (11 laboratory and 7 wild) were lowered by tongs into the aquarium for 3-10 sec., but held just out of striking range. Each mouse was then immediately transferred to a 100 x 100 x 25 cm open field with 100 10-cm squares. Experimental mice (12 laboratory and 13 wild) were treated similarly except the snake was allowed to strike the mouse after the presentation. The following variables of open field performance were recorded with hand counters and stopwatch: 1) number of squares traversed during each of 12 successive 15-sec. periods (3 min.), 2) latency to immobilization of experimental mice (in seconds), and 3) latency to death (cessation of visible respiration). The open field was wiped clean with a wet towel between trials.

Each rattlesnake was allowed to strike and consume at will only one mouse per each of five weeks (6-8 days between tests). Wild and laboratory mice were presented to each snake in a random order. Although predatory and defensive strikes elicit similar effects of envenomation in mice (O'Connell et al., 1982), caution was taken to avoid arousal of defensive behavior in the snakes.

Results

Wild control mice traveled significantly farther than laboratory control mice during the 3 min. in the open field [\bar{x} = 1702 and 975 cm, respectively; t (11) = 2.54, $P < .05$; see Figure 1]. Control groups did not differ significantly in weight (\bar{x} = 20.8 and 22.0 g, respectively). As expected, nonenvenomated mice traveled significantly farther after 3 min. than envenomated mice [F (1,39) = 66.47, $P < .001$], and the effects of envenomation were realized during the fifth 15-sec. period in the open field (Table 1). More importantly, wild experimental mice traveled significantly farther than laboratory experimental mice [\bar{x} = 462 and 206 cm, respectively; t (12) = 2.18, $P < .05$]. Although differences in weight between these two groups were significant [\bar{x} = 19.6 and 22.5 g, respectively; t (19) = 2.1, $P < .05$], there was no correlation between mouse weight and distance traveled within either group [wild: R (12) = .26, $P = .398$; lab: R (11) = -.072, $P = .824$] or both groups combined [R (24) = -.13, $P = .538$]. Furthermore, the wild experimental mice in this study appeared to travel farther than laboratory mice of previous studies involving *Crotalus v. viridis* (Estep et al., 1981; O'Connell et al., 1982; see Figure 2). That potential interaction involving envenomation vs. nonenvenomation and mouse strain was significant in the final 15-sec. period recorded [F (1,39) = 4.25, $P = .046$; Table 1] does not imply differential susceptibility to envenomation since nearly all envenomated mice were by then immobilized. Variability of the data was substantial.

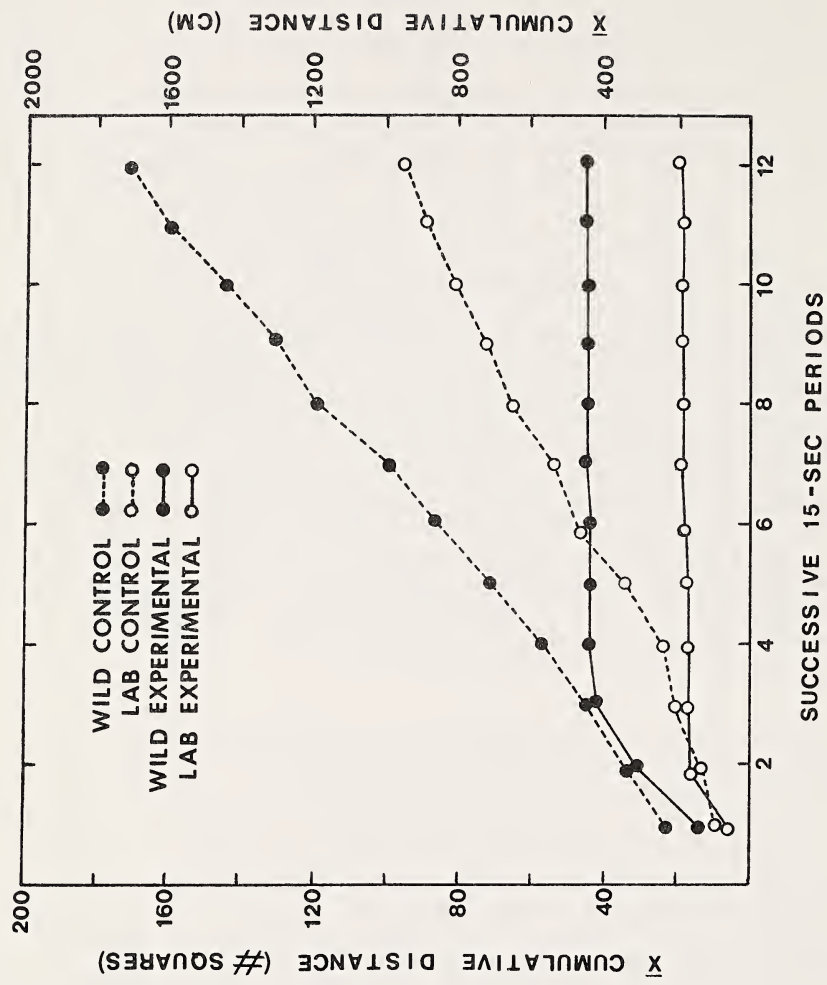


Figure 1. The cumulative distance traveled by each group in the open field, expressed as number of 10-cm squares entered and centimeters, is shown for each 15-sec. period. Experimental mice were envenomated by a rattlesnake (*Crotalus viridis oreganus*).

TABLE 1

Results of 2 by 2 ANOVAs Applied to Selected
15-Sec. Periods Shown in Figure 1

	Selected 15-Sec. Periods							
	1	2	3	4	5	6	9	12
	F Ratios (df=1,39)							
Mouse Strain	7.72*	9.87*	12.90 ⁺	17.28 ⁺	18.91 ⁺	17.93 ⁺	14.49 ⁺	12.59 ⁺
Envenomation	0.72	0.18	0.34	3.98	15.15 ⁺	24.33 ⁺	53.36 ⁺	66.47 ⁺
Interaction	2.67	0.24	0.32	0.23	0.73	1.22	2.93	4.25*
	Percent of Variance							
Mouse Strain	6.37	8.32	10.43	12.37	11.36	9.69	5.87	4.56
Envenomation	0.59	0.15	0.27	2.85	9.10	13.16	21.63	44.92
Interaction	2.20	0.20	0.00	0.17	0.44	0.66	1.19	2.87
Total S ²	143.66	481.02	961.46	1507.56	2202.56	3129.05	5388.25	9606.29
Percent of Envenomated Mice Immobilized	24.00	36.00	48.00	60.00	64.00	72.00	88.00	92.00

*P<.05 ⁺P<.01

Finally, there was no significant difference between wild and laboratory mice for latency to immobilization (\bar{x} = 53.6 and 58.4 sec., respectively) and latency to death (\bar{x} = 401.2 and 494.6 sec., respectively). Although differences between these measures and pooled results from previous studies involving *C. v. viridis* (immobilization: \bar{x} = 69 sec.; death: \bar{x} = 202 sec.) were indicated, comparison of male laboratory mice in this study with a similar group from Estep et al. (1981) revealed no statistical difference for either latency. However, the considerable variability of the data perhaps obscures venom component differences which could exist between the snake subspecies.

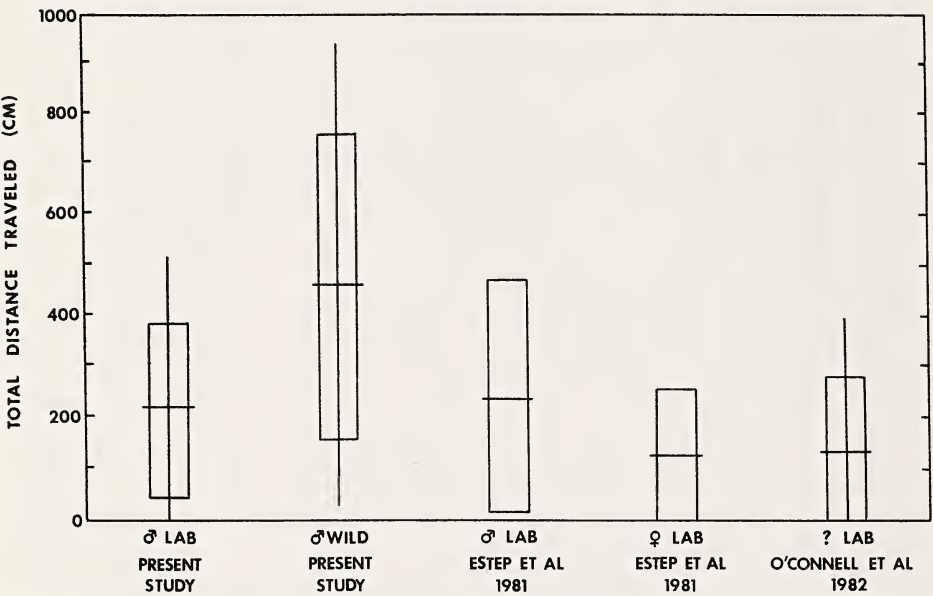


Figure 2. After envenomation by a rattlesnake (*Crotalus viridis oregonus*), the total distance traveled by mice in this study is compared with previous results involving *C. v. viridis*. Vertical line = range, horizontal line = mean, rectangle = 1 SD.

Discussion

The important outcome of this investigation confirmed the hypothesis that wild mice travel much farther than laboratory mice following rattlesnake envenomation. This difference was attributed to the greater mobility exhibited by wild mice in the open field since both suffered immobilization simultaneously. Adjusting for underestimation of the maximal distance traveled by envenomated laboratory mice due to the 2-3 sec. transfer to the open field, Estep et al. (1981) suggested a mean distance of 200 cm would be typical of rattlesnake trailing episodes. Assuming that natural prey items such as *Peromyscus* and *Perognathus* (Fitch and Twining, 1946) are capable of similar mobility and are no more susceptible to the effects of envenomation, adjustment of the present data suggests a trail length of 480-500 cm might better reflect the ordinary task confronted by rattlesnakes. Neither *Peromyscus* or *Perognathus* were available during the time of experimentation (in hibernation).

However, several mammals including prey items such as *Microtus* and *Neotoma* have recently been found to possess anti-hemorrhagic resistance to crotalid venom (DeWit, 1982). Accordingly, rodents naturally preyed upon can be expected to travel farther after envenomation than mice of similar mobility from populations which suffer no rattlesnake predation. The introduced strain of wild mice used in this study were collected from the latter category.

An investigation of the scavenging behavior of western diamondback rattlesnakes found that a rattlesnake might overlook a killed prey item if a second interfering rodent distracted it, later creating a potential situation in which putrefaction would be used as a directional cue for locating lost prey (Gillingham & Baker, 1981). The apparent selection in rattlesnakes toward holding smaller, nondangerous prey (thereby eliminating the need of trailing) and the data in this study suggest that envenomated prey may also be lost after traveling a distance farther than which rattlesnakes can often negotiate a trail. Perhaps these lost rodents also facilitate scavenging behavior. Leaping behavior of envenomated *Peromyscus* (prev. obs.), which few mice in this study demonstrated, could further complicate the trail. Whether *Crotalus viridis* exhibits a carrion search strategy remains to be documented.

The considerable variability of the data can best be attributed to the method of prey presentation, since the site of fang penetration, which was not controlled, may influence the effects of envenomation (Lester E. Harris, Jr., unpub. data; Kardong, 1982). Because the restrained mice often retaliated with bites directed toward the snake, we often presented the mice in a manner such that the head of the mouse was farthest from the snake. Consequently, many of the mice were struck in posterior regions. Ordinarily, rattlesnakes usually strike prey in the chest or lumbar region (Minton, 1969). Although we did not record the sites of envenomation, it was our impression that rump bites accelerated immobili-

zation of mice, which would seem advantageous in reducing the challenge of trailing prey. However, the risk of an unsuccessful strike launched toward the rear of a forward-moving rodent must be weighed. Hence, it is likely that prey movement, which appears to be significant in releasing the strike of a rattlesnake (Minton, 1969; see also Newman & Hartline, 1982), directs the aim of the strike as well.

Since latency for envenomated rodents to die is significantly longer than latency to immobilization, Estep et al. (1981) have suggested that strong selective pressures have produced venom components that rapidly inhibit rodent movement whether or not they also contribute to the rodents death. Perhaps selection has also favored venom components contributing to rodent death more strongly in *C. v. viridis* than in *C. v. oreganus*. This would be consistent with LD₅₀ information for venom toxicity (Glenn & Straight, 1977).

In conclusion, it was found that wild mice are more mobile than laboratory mice, and this difference was expressed even after envenomation by a rattlesnake. Moreover, future studies assessing the ability of rattlesnakes (*C. viridis*) to follow and locate envenomated rodents should use trails of at least 480-500 cm to have any ecological validity.

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EFFECT OF MALE COURTSHIP ON STRIKE-INDUCED
CHEMOSENSORY SEARCHING IN A FEMALE URACOAN
RATTLESNAKE (*Crotalus vegrandis*) AT NATIONAL ZOO

Abstract

A female Uracoan rattlesnake (*Crotalus vegrandis*) at National Zoo exhibited sustained, high rates of tongue flicking after striking rodent prey. During one observation her male cagemate initiated an unsuccessful courtship episode upon seeing the female move. Although male courtship appeared to disrupt her pattern of strike-induced chemosensory searching (SICS), she nevertheless persisted with SICS for 138 min., compared with 190 min. four weeks later when no courtship occurred. It is concluded that male courtship interfered with SICS, but only in a quantitative rather than in a qualitative way.

Rattlesnakes typically strike and release adult rodent prey (Gans, 1966; Radcliffe et al., 1980), permitting the envenomated rodent to wander up to 700 cm before succumbing to the venom (Estep et al., 1981). Striking rodent prey induces a sustained, high rate of tongue flicking in rattlesnakes and other viperids (Chiszar et al., 1977, 1982a, 1983; Dullemeijer, 1961; Gillingham & Clark, 1981a). Called strike-induced chemosensory searching (SICS), this phenomenon aids the snakes in locating and following the trails left by their envenomated prey (Golan et al., 1982; Chiszar et al., 1983). Tongue flicking transports prey-derived compounds to the vomeronasal organs, and this process contributes to successful trail following (Burghardt, 1970; Burghardt & Pruitt, 1975; Carr et al., 1982; Gillingham & Clark, 1981b; Halpern & Frumin, 1979; Halpern & Kubie, 1980; Kubie & Halpern, 1979; Wilde, 1938). Since rattlesnakes generally do not exhibit much tongue flicking until after they strike prey, SICS has been conceptualized as a transitional component of the predatory sequence of rodent-specializing rattlesnakes, mediating the change from waiting in ambush to searching actively for an ingestible carcass. This transformation is relatively long lasting in that SICS endured for an average of 2½ hours when prey were removed after envenomation and rattlesnakes were observed until they quit searching (Chiszar et al., 1982b).

Most of our research has been conducted with wild-caught rattlesnakes that were provided with live rodent prey during captive maintenance. Rattlesnakes in zoos, on the other hand, are typically fed dead rodent prey, and these snakes rarely have an opportunity to exercise their predatory skills (especially trail following). On-going studies at several zoos are assessing whether or not long-term zoo captives exhibit the same degree of persistence in SICS as wild-caught specimens (O'Connell et al., 1982). The observation here reported was made while measuring duration of SICS at the National Zoo.

Method

Two Uracoan rattlesnakes (*Crotalus vegrandis*, one male and one female) born at Houston Zoo (5/16/82), and now on exhibit at National Zoo (cage 20), were subjects in the experiment. Each snake had consumed one adult mouse (*Mus musculus*, about 20 g) two weeks prior to the first observation of this study. Also, the pair copulated soon after that feeding.

The first observation began at 09:00 (2/4/84). All tongue flicks emitted by the female were recorded for 10 successive min. Then a dead mouse (about 20 g) was suspended into the cage from long forceps and held just out of the female's striking range for 3 sec. The mouse was next moved into striking range, whereupon the female struck and released the mouse immediately. The male cagemate was coiled and inactive in the opposite side of the cage, about 50 cm from the female.

The mouse was withdrawn after being released by the female, and the observer continued to record tongue flicks until the snake quit searching (defined as 10 successive min. with no tongue flicks). Previous observations of this sort at National Zoo revealed that only the snake that struck prey exhibited SICS; the other snake(s) in the cage usually remained coiled and inactive, even when the searching cagemate crawled near or over them (Chiszar et al., 1984). Hence, there appears to be no social induction of chemosensory searching in rattlesnakes. In the present instance the male cagemate did not search for prey, but he initiated an unsuccessful 228 min. courtship episode when the female began to move (about 6 min. after she struck and released the mouse).

One month later, on 3/4/84, the female was again allowed to strike a mouse exactly as described above. The male remained coiled and motionless during the entire time the female exhibited SICS. Comparison of the female's behavior on this second trial with her behavior on 2/4/84 provides an assessment of the effect of male courtship on the female's post-strike activity.

Results

The female's rates of tongue flicking during the two trials are shown in Table 1. The two 10-min. baseline periods are shown along with the two post-strike periods, each divided into four successive 30-min. sections. It is clear that SICS occurred on both trials and that the female was influenced in only a quantitative manner by the male's sexual overtures during trial 1. Although the male was initially coiled and motionless on 2/4/84, the female's strike-induced movements aroused him. He oriented toward her (post-strike min. 6), followed her, and began to emit tongue flicks along her dorsal surface (post-strike min. 11) while she continued with SICS. No qualitative changes in the female's pattern of SICS were obvious to the observers.

Table 1

Mean rates of tongue flicking by a female Uracoan rattlesnake observed twice (one month separated the two trials). On each trial a 10-min. baseline (pre-strike) period was recorded along with four successive 30-min. periods after striking a mouse. During the first observation the male cagemate initiated a 228-min. bout of courtship upon detecting the female's first post-strike movements (post-strike min. 6). During the second observation the male remained coiled and inactive for the entire post-strike period.

Mean Rates of Tongue Flicking During Successive Periods

Date of Observation	Baseline 10 min.	Post-strike min. 1-30	31-60	61-90	91-120
2/4/84 (courtship)	0.0	34.7	21.0	6.8	9.9
3/4/84 (no courtship)	0.0	31.9	37.0	22.2	24.8
results of sign tests	P>.05	P>.05	P<.05	P<.01	P<.01

On post-strike min. 29 the male wrapped his tail tightly around the base of the female's tail, but the female simply continued with SICS and the male was dislodged after 4 min. by the female's movements. He stayed near her, directing many tongue flicks to her dorsal surface and rubbing his chin over her neck and head. He again wrapped his tail around her's on post-strike min. 40, this time achieving a strong grip which was not broken for 26 min. The female, however, did not respond to the male's courtship by remaining still. Instead, she persisted with SICS, dragging the male about as she moved. The male achieved several more tail wraps later, and several times he used his tail loop to rub the base of the female's tail (Chiszar et al., 1976).

After post-strike min. 30 the female's rate of tongue flicking during trial 1 (with courtship) was significantly reduced relative to her rate during trial 2 (without courtship; see Table 1). Although her level of SICS during trial 1 did not return to baseline until post-strike min. 138, her behavior between min. 31 and min. 138 was clearly subdued during the courtship trial. Furthermore, SICS during the second trial did not return to baseline until post-strike min. 190. Therefore, it can be suggested that the male's courtship behavior during trial 1 eventually disrupted the female's searching and hastened its termination.

Discussion

Courtship by male rattlesnakes has been summarized by Klauber (1956); and Chiszar et al. (1976) reported a peculiar form of tail rubbing that a male massasauga (*Sistrurus catenatus tergeminus*) used when a female conspecific did not respond to his initial advances. The present male *C. vegrandis* also exhibited this tail rubbing (first seen on post-strike min. 40). That the female's level of SICS then dropped sharply may be taken as evidence for a calming effect of this aspect of male courtship. Since the female had mated two weeks prior to trial 1, she was probably in a sexually refractory state during that trial, suggesting that the effectiveness of male behavior in reducing female activity was not dependent upon sexual motivation in the female.

Perhaps the main contribution of tail rubbing by the male was simply to mechanically curtail further movement by the female rather than to induce a calm psychological state; but, it is possible that both effects occurred.

In any case, SICS was reduced and more quickly eliminated during the courtship trial than during the second trial. Yet it seems remarkable that the female persisted at all beyond post-strike min. 11. The male never discontinued his efforts from this moment through the end of the observation period (min. 138), and he had his tail wrapped around her's for much of this time. Indeed, male courtship continued 90 min. past the termination of SICS by the female, but copulation did not occur. In view of this strong interference by the male, the female's persistence with SICS seems to testify to the obligate nature of this behavior and to its long duration.

The purpose of the present observation was to assess the degree of SICS persistence shown by long-term zoo captives, and to compare this with similar measures already taken on wild-caught specimens (Chiszar et al., 1982b). Since most zoos feed dead rodent prey to rattlesnakes, it is generally the case that zoo snakes have lived for long periods without any need or opportunity to execute some aspects of their innate predatory repertoires, especially persistent searching and trail following. Accordingly, it is possible that predatory behavior may be degraded as a consequence of captive maintenance, and that long-term zoo captives would be at a disadvantage if they were to be released into suitable natural habitat. So far, however, our observations indicate that zoo-maintained rattlesnakes exhibit SICS (O'Connell et al., 1982), and that SICS persists as long in zoo snakes (including second and third generation captive-born rattlesnakes at San Diego Zoo) as it does in wild-caught specimens that fed exclusively upon live prey in captivity (Chiszar et al., 1982b). The behavior of the present captive-born specimen is consistent with this accumulating data base.

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NOTES ON THE ENIGMATIC *Barisia imbricata* OF THE
BRITISH MUSEUM, AND ON ITS COLLECTION OF REPTILES FROM
AMULA, GUERRERO, MEXICO

The small collections of reptiles from "Amula" (= Almolonga, fide Davis and Dixon, 1959:80), Guerrero, Mexico, obtained by H. H. Smith in 1889, for the British Museum, have long been a source of concern because of the report of *Sceloporus variabilis*, an Atlantic slope (and trans-isthmian Pacific slope) species, and *S. acanthinus*, a trans-isthmian Pacific slope species, from there. In order to provide a definitive identification of the enigmatic specimens, and to determine whether locality or previous identification were in error, the entire series was borrowed for study through the courtesy of A. F. Stimson and the authorities of the British Museum (Natural History). At the same time three enigmatic specimens of *Barisia* were borrowed to determine whether any might represent species other than *B. imbricata*, to which taxon they had long been assigned.

The collection purportedly from Amula gives no basis for questioning the veracity of locality data; part of the material had been misidentified, and part has never been recorded previously. The examples of *Barisia* likewise proved to be correctly assigned to *B. imbricata*, although two of them exhibit unusual variations. Hence the entire lot of borrowed specimens is reported here to correct and augment the record.

Abronia deppei (Wiegmann). The single specimen (1913.7.19.102) is an adult 103 mm s-v, tail 119 mm. It is more or less typical of the species, except that the two lower anterior temporals contact the postoculars, rather than the lower only, and the anterior superciliary contacts the cantholoreal. Otherwise the specimen agrees with descriptions, having among other characters 26 scales nuchals to base of tail, six minimum nuchal scale rows, three postoccipital scale rows on head, penultimate labial contacting orbital scales, three temporals contacting labials, 3-4 anterior nuchal rows with osteoderms, a small supranasal, a loreal, divided postmental, 119 caudal whorls. The color is exceptionally light although the specimen does not seem to be faded, as the dark crossbars are very distinct. There are six dark crossbars on neck and trunk, nine on tail excluding dark tip. The crossbars are narrow but irregular and broken, separated from each other by spaces almost twice as long as the crossbars.

This is the only specimen recorded from regions east of Chilpancingo, although Amula is only a short distance (35 km) from the city (see Davis and Dixon, 1959:80, Fig. 1, for localities and vegetational map). Davis and Dixon (1961:82) reported specimens only from the Omiltemi area. Although the specimen has apparently not been recorded previously, it actually must have been available to Boulenger, who in 1913 described *Gerrhonotus gadovii* from Omiltemi, on the basis of specimens catalogued at the same time as the present example of *A. deppei*.

Barisia imbricata imbricata (Wiegmann). Three specimens are of special interest: 71.2.7.4 from "Tehuantepec," Oaxaca, and 1903.9.30.118-119 from "above Xometla," on Mt. Orizaba, 10,000-11,000 ft., Veracruz.

The specimen supposedly from Tehuantepec, a female about 94 mm s-v, tail regenerated, has 12 longitudinal dorsal and ventral scale rows, 39 transverse dorsal scale rows, 10-10 supralabials, 7-8 infralabials, an unpaired postmental, and the mode for all other characters reviewed for the subspecies by Guillet and Smith (1982:19). The pattern is unusual, with dark sides transversed by about 9-10 narrow vertical light bars; dorsum light tan, sharply delimited from the dark sides along the keels of the 3rd scale row (from midline); a dark brown line down the adjacent halves of the paravertebral scale rows, from occiput onto tail, continuous only on neck, elsewhere broken into sections 2-3 scales long by gaps 0.5-1 scales long; ventral surfaces unmarked.

Apparently this specimen is unique among all recorded of the *imbricata* group, in both pattern (normally unicolor or crossbarred on dorsum as well as sides, never with a median stripe) and the unpaired postmental (always paired). Indeed, these features are characteristic of members of the *moreleti* group. Nevertheless the aberrant individual is here regarded as simply an anomalous example of *B. i. imbricata*, with which it agrees in all details of scutellation and body size, whereas it differs in many respects from *B. viridiflava*, the member of the *moreleti* group that agrees most closely with the *imbricata* group. It is not likely a hybrid between *B. imbricata* and *B. viridiflava*, since it has fewer dorsal scale rows (12) than either the former species in Oaxaca (16) or the latter (14). Obviously the locality data are incorrect, but no clue to actual provenience is apparent; presumably the specimen came from somewhere in the southern part of the main plateau of Mexico, definitely not from the Tehuantepec area.

One of the two specimens from "above Xometla" (1903.9.30.118) is a typical adult, unicolor male 107 mm s-v, with 14 dorsal scale rows. The other specimen, however, a juvenile 62 mm s-v, has 14, 15 or 16 dorsal scale rows at different points on the trunk - the only one with more than 14 recorded since the 1982 review of the species (Guillet and Smith, 1982:19). It also has 42 transverse rows of dorsals, interparietal to base of tail - the maximum recorded for the subspecies (loc. cit.). Presumably these aberrant or unusual character-states have no significance, except as anomalies, since otherwise the specimen is typical of its subspecies.

The two specimens demonstrate that *B. i. imbricata* exists on Mt. Orizaba at altitudes (10,000-11,000 ft.) at least close to if not overlapping with that of the very high altitude *B. antaues* (12,500 ft. the only reliable record, in Gadow, 1908:61). The altitude itself is not exceptional, since numerous examples have been recorded elsewhere at altitudes above 10,000 ft. (Guillet and Smith, 1982:30-3), even up to 13,000 ft. on Volcan Popocatepetl (loc. cit.). A more important question, as yet unanswered, is the vertical range of *B. antaues* (*B. modestus* a jr. synonym) on Mt. Orizaba.

Gerrhonotus liocephalus liocephalus Wiegmann. A single example (1913.7.19.103), also catalogued at the same time as the preceding specimen of *Abronia deppei* and the types of *Barisia gadovii* (Boulenger), has never been reported in the literature but undoubtedly was a major factor in discovery by Boulenger that his earlier identification of two specimens from Omiltemi of the latter species, reported by Gadow (1905: 195, 233; 1908:380) as *Gerrhonotus liocephalus*, was in error, particularly since additional specimens of *B. gadovii* were included in the 1913 collection from Omiltemi.

This appears to be a far less common species than *B. gadovii* in Guerrero; only two reported by Davis and Dixon (1961:53) from Acahuizotla, in addition to the present, are known from the state, whereas dozens of *B. gadovii* and even numerous *Abronia deppei* have been reported from the same general area. None has as yet been taken in the Omiltemi area.

The Amula specimen is an adult, 142 mm s-v, with a regenerated tail; 14 midbody scale rows, 10 on nape; 60 dorsals, interparietal to level of rear margins of thighs; 12 longitudinal rows of ventrals; anterior internasals contacting rostral, separated medially by an irregular-shaped postrostral contacting right posterior internasal but separated from left by an azygous scale; supranasals large but widely separated medially by postrostral; two superimposed postnasals, followed by a loreal superimposed by a canthal; a large cantholoreal narrowly contacting frontonasal; one preocular, entire, contacting anterior superciliary; 2-3 suboculars; 8-8 supralabials to rear edge of subocular, 9th much enlarged, reaching orbit on one side (no postocular separating it); postoculars 1-3; 11-11 supralabials; prefrontals in medial contact; 5-5 inner, 3-3 outer supraoculars, 2nd inner broadly contacting prefrontal; frontoparietals 1-1, separated by frontal-interparietal contact; parietals 1-1, separated posterior to interparietal by a median occipital; anterior and posterior temporals 4-4; 9-9 infralabials; postmental asymmetrically divided. Dorsum nearly uniform tan, crossbands very faint; venter unmarked.

Although the geographic races of the species are in need of review, it appears that the number of longitudinal rows of dorsals is diagnostic of the nominate subspecies; that character has not been noted in previous comparative accounts (e.g., Tihen, 1948, 1954; Smith and Taylor, 1950). A revised key to the subspecies, with their approximate ranges, follows. It seems likely that at least one subspecies has not been named; none has been adequately studied, hence no key can now be regarded as definitive.

Key to Subspecies of *Gerrhonotus liocephalus*

1. Fourteen longitudinal rows of dorsals; a total of three loreals, canthals or loreocanthals on each side; the southern central plateau and Sierra Madre del Sur, Guanajuato, Hidalgo and Querétaro to Guerrero, Oaxaca and western Chiapas -----*liocephalus*

- Sixteen or more longitudinal rows of dorsals; loreal-canthal scales
3 or 4 -----2
2. No supranasals; loreal-canthal scales three on each side; extreme
southwestern Chiapas and presumably adjacent Guatemala---*austrinus*
Supranasals present; loreal-canthal scales four on each side -----3
3. Longitudinal scale rows 18 dorsally, 14 ventrally, and transverse
rows of dorsals 55 or more; western Chihuahua -----*tailori*
Longitudinal scale rows 16 dorsally or 12 ventrally, or transverse
rows of dorsals fewer than 55 -----4
4. Second primary temporal usually contacting 5th medial supraocular;
southeastern San Luis Potosí -----*loweryi*
Second primary temporal usually separated from 5th medial supra-
ocular -----5
5. Usually 18 longitudinal dorsal scale rows; southern Sinaloa and
adjacent Durango -----*nomen vacuum*
Usually 16 longitudinal dorsal scale rows -----6
6. Caudal whorls 116-137; tail shorter, 1.75-2.1 times body length;
Texas southward to central San Luis Potosí -----*infernalis*
Caudal whorls more numerous, 140 or more; tail longer, 2.3 times body
length; eastern foothills of the Sierra Madre in Veracruz and
Puebla -----*ophiurus*

Phrynosoma taurus Dugès. Three examples (89.11.13.94-96) are typical of the species; two are adult males, 55-59 mm s-v, one a half-grown male 35 mm s-v. All have the ventral scales keeled; femoral pores 12-13, 10-10, 9-10 respectively. The temporal horns diverge outward in the two smallest specimens, but in the largest curve medially so that they parallel each other toward their tips.

Günther (1890:79) correctly reported these specimens. Only one was taken in the collections reported by Davis and Dixon (1961:43); the species may have become less abundant in recent years.

Sceloporus formosus scitulus Smith. A single adult female (89.11.13.93), 63 mm s-v, contains large eggs (10 mm) in the oviducts; 15-15 femoral pores; 31 dorsals; pattern of irregular, small dark spots covering 1-3 scales on back and sides; a pair of dorsolateral light lines on neck, extending posteriorly from orbit, bordered on both sides by a dark line, the lateral one terminating in continuity with a vertical dark line in front of arm insertion; ventral surfaces immaculate.

This specimen was reported as *S. acanthinus* by Boulenger (1897: 497), who noted that Günther (1890:64) had referred the same specimen to *S. spinosus*. The taxon has also been recorded from nearby Davis and Dixon (1961:43-44), at 2.5 mi. S. Almolonga (5600-5800 ft.).

The area of intergradation between this and the nominate subspecies remains to be determined. Specimens from Cerro Yucuyagua, 8 km SSE Tlaxiaco, Oaxaca (CUM), represent the nominate subspecies, hence the area of contact with *S. f. scitulus* must lie somewhere between there and Amula.

Sceloporus ochoterenai Smith. Five juveniles (89.11.13.83-87), 19-24 mm s-v, are readily identifiable with this species by the absence of postrostral scales (resulting in contact of nasals and internasals with the rostral), the absence of a postfemoral dermal pocket, and the presence of preanal keels in females. Only two other species of the genus possess the first character, and neither occurs on Pacific slopes of Mexico.

Günther (1890:75) referred these specimens to *S. variabilis*, but Boulenger (1897) did not attempt to allocate them, presumably because of their extremely small size. Davis and Dixon (1961:47) reported the species from nearby, at 2.5 mi. S. Almolonga, 5600 ft.

Sceloporus spinosus horridus Wiegmann. Five juveniles (89.11.13.88-92), the largest 38 mm s-v, the smallest 28 mm s-v, have 3-3(2), 3-4(1), 4-4(2) femoral pores; prefrontals in contact in three, separated by an azygous scale in one, by contact of frontal with frontonasal in one; and preocular divided in three.

These specimens have not previously been reported, although they certainly were available both to Günther and Boulenger, having been catalogued at the same time as the specimen of *S. formosus scitulus*. Presumably their small size discouraged any attempt to identify them.

They actually are somewhat intermediate between *S. s. horridus* and *S. s. oligoporus*, with a higher percentage having fewer than seven femoral pores (40%) than normally expected in *S. s. horridus* (19% over-all, fide Smith, 1939:105). The prefrontals likewise are more frequently in contact (60%) than expected (31%). The preocular character (80% entire on one or both sides) is about as expected, however, for *S. s. horridus* (82%). The significance of the skewness of variation toward norms for *S. s. oligoporus* apparently lies in the expected geographic range of the latter subspecies a considerable distance up the valley of the Balsas river, to which Amula is fairly close (see map in Davis and Dixon, 1959:80, Fig. 1). A fine series of 15 specimens was reported by Davis and Dixon (1961:45) from Amula, as well as from other localities nearby but on coastal drainages rather than the Balsas drainage. A detailed analysis of variation in these specimens and in other material would clarify the interdigitation of the ranges of *S. s. horridus* and *S. s. oligoporus*. It is to be expected that the coastal populations would exhibit little or no influence of *S. s. oligoporus*.

The concept of conspecificity of *S. horridus* and *S. spinosus* proposed by Boyer et al. (1982) is here accepted, although evidence to the contrary is in press (Darrell Frost, pers. comm.).

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REPTILIAN PARTHENOGENESIS

Abstract

Parthenogenetic species are found in the fishes, amphibians, and in seven families of reptiles. Six parthenogenetic lizard families are found worldwide in temperate and tropical regions. Parthenogenesis may have arisen separately several times in these families spontaneously or by hybridization. Complete chromosome number may be maintained by premeiotic inhibition of mitotic cytokinesis. Invariability of the genetic pool in these species may regulate the habitats they are capable of occupying.

In some populations of lizards--in fact, in some entire species of lizards--there are no males. Females produce offspring without any male input. All of the young are females, genetically identical (except for random mutation) to the mother. They in turn are able to produce young without any contribution from male lizards. This account reviews the mechanisms behind, the significance of, and the frequency with which this phenomenon, known as parthenogenesis, occurs.

Many invertebrates may reproduce parthenogenetically, but among vertebrates reproduction without fertilization by a spermatozoon is known to occur naturally only in a very few reptiles, amphibians, and teleost fishes. Turkeys can be artificially induced to reproduce parthenogenetically. Fishes with a parthenogenetic strategy include some perches, darters, and basses. Parthenogenetic reproduction in amphibians is of a special type known as gynogenesis in which females mate with males and the spermatozoon penetrates but does not fertilize the egg (Cuellar, 1976a). In many vertebrates an ovum or zygote may be induced to cleave and divide by some physical manipulation such as a pin prick. More interesting is reptilian parthenogenesis in which there is no real mating. In fact, there are no males of the same species with which to mate. Sometimes two females engage in pseudo-copulation; one female having already ovulated acts exactly like a male (except for intromission) and mounts a female with large yolking eggs still in the ovary (Crews and Fitzgerald, 1980). But ovulated eggs develop without any external provocation.

Although this type of reproduction does not follow the major trend of reproductive evolution in vertebrates and is different from the classic classroom descriptions of vertebrate reproduction, parthenogenesis is neither all that rare nor isolated. One snake and six families of lizards include species which are parthenogenetic. They occur on all continents in which reptiles are found.

The lone species of snake in which parthenogenesis has been discovered is the Braminy Blind Snake (*Ramphotyphlops braminus*). It is a small snake of less than 8 inches which burrows among the roots of plants.

Its distribution is old world including Madagascar, southeastern Asia, East Indies, and many Pacific islands, but it has also been introduced into suitable new world habitats in southern Mexico and Hawaii.

Many more lizards are parthenogenetic, including representatives of the agamids, chameleons, gekkos, lacertids, teiids, and xantusiids (Cole, 1975). On this continent perhaps the most parthenogenetically prolific family, the Teiidae, occurs. Most of these species are found in the deserts of the southwestern United States and northern Mexico. Included are the Cozumel whiptail (*Cnemidophorus cozumela*), the gray checkered whiptail (*C. dixonii*), Chihuahuan spotted whiptail (*C. exsanguis*), Gila whiptail (*C. flagellicaudus*), Laredo striped whiptail (*C. laredoensis*), New Mexican whiptail (*C. neomexicanus*), Sonoran whiptail (*C. opatae*), Yucatan whiptail (*C. rodecki*), Sonoran spotted whiptail (*C. sonorae*), checkered whiptail (*C. tessellatus*), desert-grassland whiptail (*C. uniparens*) and the plateau striped whiptail (*C. velox*). All of these North American and Mexican parthenogens have arisen in one genus, *Cnemidophorus*. In South America, teiids which are parthenogenetic include the spectacled lizard (*Gymnophthalmus underwoodi*), the dwarf teiid (*Leposoma percarinatum*), the keeled whiptail (*Kentropyx borekianus*) and one species that is facultatively parthenogenetic (that is, it is only parthenogenetic under certain environmental conditions), the South American whiptail (*C. lemniscatus*).

The lacertid lizards were the first reptiles discovered to be parthenogenetic (Darevsky, 1958). They are European and occur in the Caucasus Mountains from the Black Sea to the Caspian Sea. They include four species of Wall lizards (*Lacerta armeniaca*, *L. dahli*, *L. rostombekovi*, and *L. unisexualis*).

The parthenogenetic gekkos are found on many islands of the Pacific and in southeastern Asia. They are the Indo-Pacific gecko (*Hemidactylus garnotii*) and the mourning gecko (*Lepidodactylus lugubris*). All lizards so far investigated with three sets of chromosomes are parthenogenetic. Therefore it is suspected that the triploid gecko (*Gehyra variegata ogasawarisimae*) is also parthenogenetic.

The parthenogenetic chameleon (*Brookesia spectrum affinis*) is found in Africa. In Malaya there is a parthenogenetic agamid (*Leiolepis triploida*). A facultative parthenogen in Central America is a xantusiid (*Lepidophyma flavimaculatum*) (Cole, 1978).

It's obvious from the world wide distribution of parthenogenetic lizards and their occurrence in several families that parthenogenesis has arisen separately several times and that we likely have not discovered all of the parthenogenetic lizard species. It is also possible that, evolving in different taxonomic groups, parthenogenesis came about via different pathways or mechanisms. The mechanism of parthenogenesis, however, must somehow include a form of meiotic restitution. That is, the chromosome number in a haploid egg must at least be restored to the

full diploid complement equal to that which would have been supplied by both the male and the female (Cuellar, 1971). There are five places during meiosis when this could happen. The first is just before meiosis when the cells in the germinal bed are still dividing mitotically. If during the last mitotic cell division the splitting of the cell membrane and contents (cytokinesis) is inhibited then the divisions of meiosis, which reduce the chromosome number by half, will leave a full complement of chromosomes in the ovum. The second possibility is that during the first chromosome split of meiosis, when homologous pairs (father's matching mother's) line up and separate, this division is aborted. Again there will be twice the chromosome number when the tetrads line up singly and are split at the centromere, during the second meiotic division which reduces the chromosome number by half. Of course, if the second meiotic division is inhibited, and not the first, the ovum will still end up with the diploid (adult) number of chromosomes. The fourth and fifth mechanisms for restoring full chromosome number to an ovum of a parthenogenetic lizard involves fusion of two nuclei which house the genetic material. During normal meiosis the reduction divisions produce one ovum and 3 inviable polar bodies from one primary oocyte (first stage after germinal bed). Fusion of the nucleus of a polar body with that of the ovum would restore full chromosome number to the ovum. Also if the ovum undergoes cleavage (mitotic division) without fertilization then fusion of the nuclei of the first two cells would result in one cell with a complete chromosome set, which would continue to divide, and one cell with no genetic material.

Only one of these mechanisms has any evidence collected in support of it. In the desert-grassland whiptail observations of the chromosomes at the first division revealed a doubled set of chromosomes (Cuellar, 1971). This indicates that this chromosome doubling occurred prior to meiosis. Different investigators argue whether this chromosome restitution can occur spontaneously in offspring of bisexual lizards or only in hybrid offspring from a mating of two different bisexual lizard species. The evidence is inconclusive but rather convincing for both hypotheses.

In many areas a parthenogenetic species (e.g., checkered whiptail) is found geographically distributed between two bisexual lizard species (e.g., Western whiptail (*C. tigris*) and the plateau spotted whiptail (*C. gularis septemvittatus*)). The parthenogenetic lizards are intermediate in ecology and morphology as well as distribution between their bisexual neighbors. The New Mexican whiptail has been found to be cytologically and biochemically intermediate between the Western whiptail and the little striped whiptail (*C. inornatus*) (Brown and Wright, 1979). All of these factors point toward hybridization as the trigger for the unusual chromosome restitution. But there are cases in which the lizard is facultatively parthenogenetic and/or there are no similar (congeneric) bisexual lizards living in habitats adjacent to the parthenogenetic species (e.g., *C. lemniscatus* and *L. flavimaculatum*). In these cases there would be no stock from which to derive a parthenogenetic hybrid. Even more convincing support for the idea of spontaneous chromosome restitution is the evidence

from intraclonal histocompatibility studies. If a piece of skin is grafted from one lizard to another it should only be accepted by the second lizard if it is essentially genetically identical to the first. There appears to be remarkable genetic integrity between individuals of a parthenogenetic species (Cuellar, 1976b). The degree of genetic homogeneity suggests that an entire species may have evolved from one individual lizard. It is likely that hybridization would occur infrequently but often enough to contribute more heterogeneity to the gene pool of the parthenogenetic species.

Whatever the mechanisms responsible, the fact that parthenogenetic species do exist represents an unusual opportunity to look into the advantages associated with sexual reproduction and nonsexual reproduction. The parthenogenetic lizards obviously have the advantage of complete reproductive capacity in every animal rather than reproductive capacity being attained only through union of two animals. More simply, all parthenogenetic lizards are females so they can all produce eggs. Normal sexual lizards have populations which are only half female, therefore only half the population can produce eggs. If you assume that the parthenogenetic lizards must be ecologically very similar to the sexual lizards from which they sprang then it is very difficult to understand why there are any similar sexual lizards left.

Imagine a population of 12 sexual lizards and one newly derived parthenogenetic lizard. For simplicity, let's assume that the clutch size of these animals is two and that the adults die when the young are hatched --even replacement. In the next generation there would remain 12 sexual lizards (2 from each of six females) but there would now be 2 parthenogenetic lizards, again both females. The succeeding generations would see populations with 4, 8, 16, 32, and 64 parthenogenetic lizards in the 7th generation, but there would always be only 12 sexual lizards. Remembering that the parthenogenetic lizards have the same genes as the sexual lizards from which they came, they are subject to the same ecological limitations as the sexual lizards. If a natural event decimated the population or if many of the lizards died because carrying capacity of the habitat had been surpassed, a proportionate number of sexual and parthenogenetic lizards would die. If a natural event in the seventh generation reduced the population size back to twelve, eleven of the lizards would now be parthenogenetic. Since it takes two sexual lizards to produce any offspring it's obvious that the following generation would contain only parthenogenetic lizards.

But this does not occur. Sexual lizards remain dominant in their habitats and parthenogenetic lizards often are found only on the periphery of the habitat, or in habitats which are not stable, such as river washes (Cuellar, 1977; Wright and Lowe, 1968). This may suggest that the variability between sexual individuals allows each animal to exploit resources different enough from those of his neighbor that these animals don't always have to compete. Since parthenogenetic lizards are clones

with no variability (except that due to random mutation), competition between individuals may be very much greater. This competition may reduce the energy stores needed for reproduction, establish stress-induced hormonal inhibition of reproduction, or both.

Parthenogenetic lizards represent a natural experiment of the evolutionary trend toward greater genetic recombination. Discovering and exposing new parthenogenetic species and their habitats may help give some insight into the conditions which favor sexual differentiation by looking at those which do not. Paradoxically they may help us understand the basic principles common to most vertebrate species, that is sexual species.

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A NEW SUBSPECIES OF *Centrolenella orientalis*
(ANURA: CENTROLENIDAE) FROM TOBAGO, WEST INDIES

Rivero (1968) described *Centrolenella orientalis* on the basis of a single specimen collected on Mt. Turumiquire, Venezuela, June 24, 1967 (MCZ 72497). A strikingly similar frog (Fig. 1) was recently discovered on the island of Tobago, West Indies (Hardy, 1977). Duellman (1977), working without benefit of specimens or field experience, assumed that the Tobago *Centrolenella* was identical to *Centrolenella orientalis* of Venezuela and published the rather remarkable statement that *Centrolenella orientalis* occurs in "the mountains of northeastern Venezuela" (thus implying a broader geographic range than was previously known) and on the island of Tobago. Zweifel (1977) noted that the distance between Tobago and Mt. Turumiquire is 370 kilometers, and pointed out that Duellman's comments should have been documented.

In 1982 I listed the Tobago frog as *Centrolenella cf orientalis*, primarily because I had been unable to collect additional specimens of *Centrolenella orientalis* in Venezuela. At the present time *Centrolenella orientalis* remains known only from the holotype. Recent work in Tobago, however, coupled with a detailed study of morphometric data from both populations, suggest that the Tobago frog is, indeed, conspecific with *Centrolenella orientalis* of Venezuela, but is subspecifically distinct. The Tobago population shall be known as:

Centrolenella orientalis tobagoensis subsp. nov.

Holotype. USNM 195045, collected on August 31, 1972, along the Roxborough-Partatuvier Road in the vicinity of Bloody Bay, St. John Parish, Tobago (Fig. 2).

Paratypes. Twenty-nine specimens from Tobago as follows: USNM 192745, Windward Road, vicinity of mile marker 22½ near Lambeau Hill Crown Trace, St. Paul Parish, 11 July 1971; USNM 194999-5000, Windward Road, vicinity of mile marker 22½, near Lambeau Hill Crown Trace, St. Paul Parish, 28 August 1972; USNM 195031-34, Windward Road, vicinity of mile marker 22½, near Lambeau Hill Crown Trace, St. Paul Parish, 30 August 1972; USNM 195039, Charlotteville-Bloody Bay Road, near Hermitage, vicinity of mile marker 30, St. John Parish, 30 August 1972; USNM 195040, Charlotteville-Bloody Bay Road, near Hermitage, vicinity of mile marker 27½, St. John Parish, 30 August 1972; USNM 195044, Roxborough-Partatuvier Road, vicinity of Bloody Bay, St. John Parish, 31 August 1972; USNM 195152-55, Windward Road, vicinity of mile marker 22½, near Lambeau Hill Crown Trace, St. Paul Parish, 14 September 1972; USNM 195157, Windward Road, vicinity of mile marker 22½, near Lambeau Hill Crown Trace, St. Paul Parish, 16 September 1972; USNM 227732, 3.75 mile WSW of Charlotteville, Northside (Bloody Bay) Road, mile



Figure 1. The Tobago *Centrolenella* photographed alive.
A. Dorso-lateral view. B. Ventral view.

marker 27½, St. John Parish, 17 November 1971; USNM 227733-40, 3.75 miles WSW of Charlotteville, Northside (Bloody Bay) Road, mile marker 27½, St John Parish, 16 November 1971; USNM 227741-42, Windward Road, vicinity of mile marker 25½, near Lambeau Hill Crown Trace, St. Paul Parish, 16 November 1971; USNM 227743, 2 miles WSW of Charlotteville, Northside (Bloody Bay) Road, Hermitage, at mile marker 29.5, St. John Parish, 16 December 1978; USNM 227744-45, 2 miles WSW of Charlotteville, Hermitage Bridge, along Northside (Bloody Bay) Road, at mile marker 29½, 23 December 1978.

Range. Known only from mountainous areas on the island of Tobago, West Indies (Fig. 3).

Diagnosis. Maximum length 22.9 mm; tympanum hidden; vomerine teeth and humeral spines absent; first finger equal to or longer than second; toes three-fourths webbed; dorsal surfaces green, with or without black or yellow punctations; belly granular; dorsal surfaces smooth.

Description of the holotype. A male; snout-vent length, 21.7 mm; head width, 7.9 mm; tibia length, 10.8 mm. In preservation, dorsum light straw-colored and with about twelve conspicuous black dots scattered randomly among a pattern of evenly-spaced, small melanophores. Similar small melanophores in a narrow band along the top of the femur, and continuing down the leg to the bases of the toes. Upper arm unpigmented throughout. Lower arm with scattered melanophores. Ventral surfaces flesh-colored, unpigmented.

Color in life (based on recent field observations). Body pale leaf-green above, with or without scattered small black melanophores, larger black spots, and lemon-yellow punctations. Upper jaw flesh-colored, unpigmented. Limbs, except upper arm, green dorsally, with or without punctations. Upper arm flesh-colored, entirely unpigmented. Femur with a narrow line of green dorsally, otherwise flesh-colored. Toes and toe pads pale to deep lemon yellow. Belly transparent centrally, whitish or pale green and somewhat opaque toward the edges. Throat flesh-colored, or extremely pale green. Eye bright canary yellow with scattered, large melanophores which tend to form a ring around the pupil.

Variations in the paratypes. The paratypes vary from 20.2 to 22.9 mm in snout-vent length, and from 10.5 to 12.2 mm in tibia length. In the preserved series, large dorsal pigment spots may be present or absent (Fig. 4); otherwise the paratypes are remarkably similar to one another.

Comparisons. *Centrolenella orientalis tobagoensis* may be distinguished from *Centrolenella orientalis orientalis* on the basis of relative tibia length (shorter in Tobago), and, presumed, less intense pigmentation.

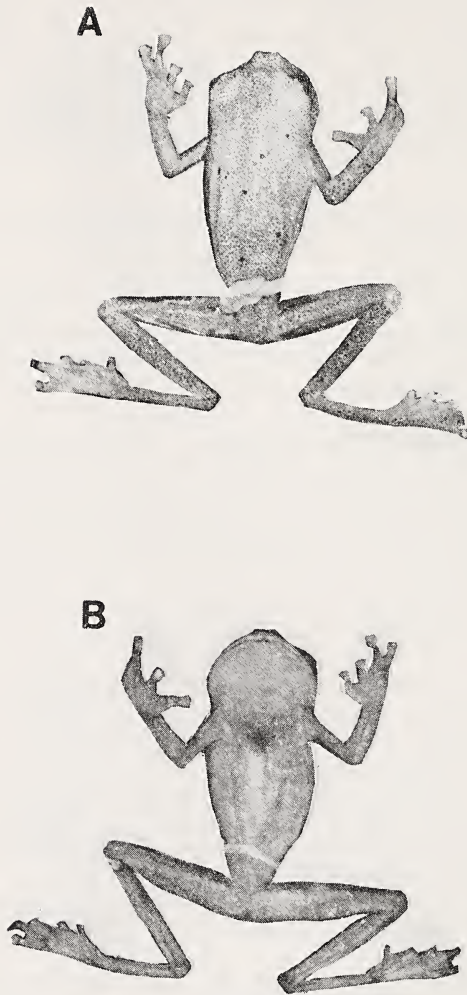


Figure 2. *Centrolenella orientalis tobagoensis*, the holotype (USNM 195045). A. Dorsal view. B. Ventral view.



Figure 3. Distribution of *Centrolenella orientalis orientalis* and *Centrolenella orientalis tobagoensis* in northeastern Venezuela and the southeastern Caribbean.

Rivero (1968) gives a snout-vent length of 21.2 mm, and a tibia length of 12.2 mm for the holotype of *Centrolenella orientalis orientalis*. These figures result in a snout-vent/tibia length ratio of 1.74. I have examined the holotype of *Centrolenella orientalis orientalis* and agree with Rivero's original measurements. In *Centrolenella orientalis tobagoensis* snout-vent/tibia length ratios vary from 1.84 to 2.04 with a mean of 1.93 (Fig. 5).

Results of statistical analysis done on these ratios indicate that *Centrolenella orientalis tobagoensis* is morphometrically distinct from *Centrolenella orientalis orientalis*. The standard deviation of the Tobago population is 0.056. The 1.74 snout-vent/tibia length ratio of the single specimen of *Centrolenella orientalis orientalis* is 3.4 standard deviations less than the mean value of this ratio for *Centrolenella orientalis tobagoensis*. Assuming that these ratios are normally distributed in *Centrolenella orientalis tobagoensis*, the probability of observing a value as low as 1.74 in this population is 0.0003 or 1 in 3,333. Application of a statistical test for comparing a single observation to a sample mean (Sokal and Rohlf, 1969) resulted in a "t" value of -3.338 which is significant at the $\alpha = 0.01$ level.

Rivero (1968) stated that *Centrolenella orientalis orientalis* is green below, tending toward blue on the throat and chest, and that the discs of the toes are somewhat orange. In recently collected specimens from Tobago, the ventral surfaces of the body are extremely transparent,

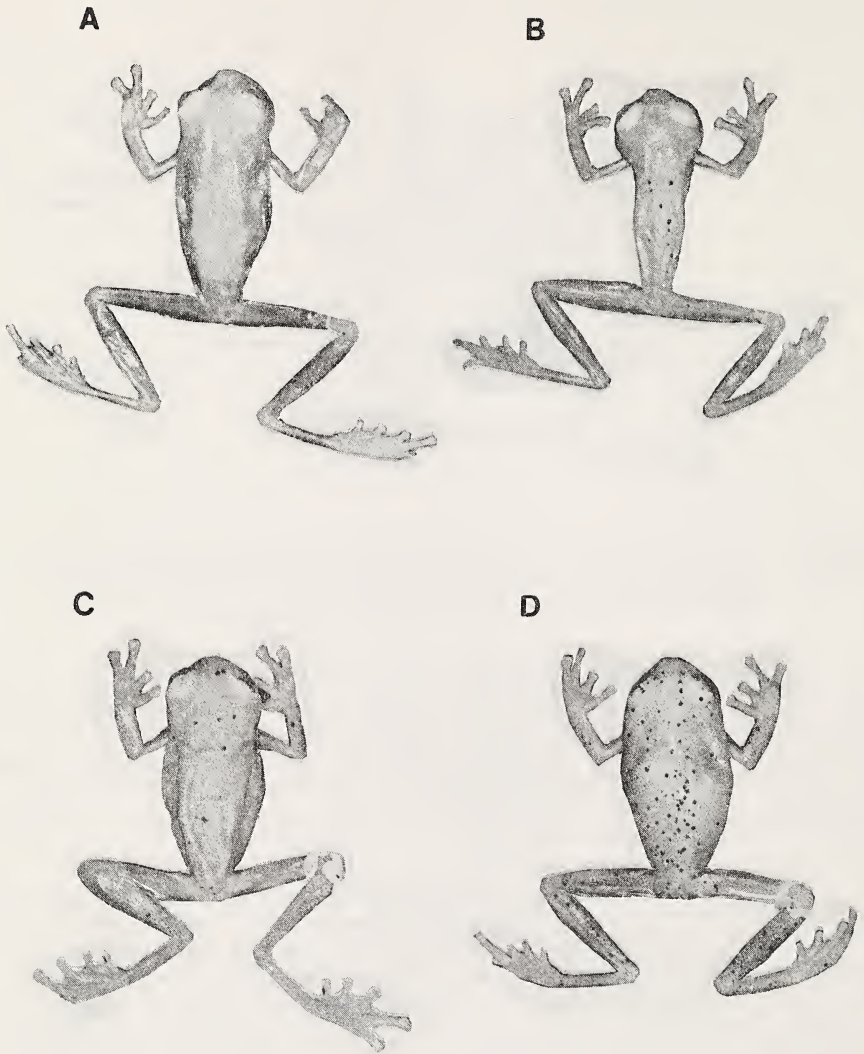


Figure 4. Paratypes of *Centrolenella orientalis tobagoensis* showing variation in dorsal pigment. A. USNM 227737. Large dorsal spots entirely absent. B,C. USNM 227736, USNM 195152. Moderately developed dorsal spots (typical of approximately 90% of the paratypes). D. USNM 195155. Maximum development of dorsal spots. This single specimen approaches the condition seen in the holotype of *Centrolenella orientalis orientalis*.

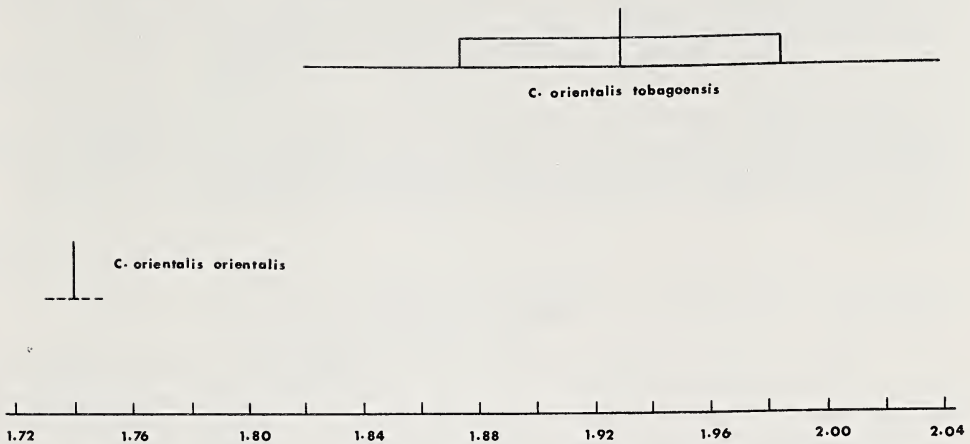


Figure 5. Statistical analysis of the snout-vent/tibia length ratios of the two populations of *Centrolenella orientalis*. The broad band represents one standard deviation on each side of the mean.

becoming somewhat opaque toward the sides, and may be pale flesh-colored, whitish, or very pale light green. The throat and chest regions are flesh-colored or pale transparent green, and there is no suggestion of blue pigment. The toes and toe discs are yellow throughout. Tiny yellow punctations occur on the dorsal surfaces of at least some specimens of *Centrolenella orientalis tobagoensis*. Similar punctations were not mentioned in the type description of *Centrolenella orientalis orientalis*. The holotype of *Centrolenella orientalis orientalis* has numerous large, black spots over most of the head and body. Only one specimen of *Centrolenella orientalis tobagoensis* approaches this pattern (USNM 195155, see Fig. 4). If the holotype of *Centrolenella orientalis orientalis* is assumed to be an average specimen, then *Centrolenella orientalis tobagoensis* is probably a less well-spotted frog. As Rivero (1968) pointed out, it is unfortunate that the eye pigment of *Centrolenella orientalis orientalis* has not been described.

Discussion. The northeastern limits of the range of the family Centrolenidae in Venezuela is not well known. Rivero (1980) indicates the northeastern edge of range as the vicinity of Mt. Turumiquire. Juan Leon (personal communication) states, on the other hand, that the genus *Centrolenella* occurs on the Paria Peninsula. Regardless of the range of *Centrolenella* in Venezuela, there is good evidence to show that this genus does not occur on the island of Trinidad (Kenny 1969, 1977). The

Tobago *Centrolenella* is, in fact, one of a number of vertebrate animals (4 frogs, 1 lizard, 1 snake, 11 birds, and 2 mammals) which occur on Tobago but not in Trinidad and are strikingly similar or identical to species occurring in Venezuela (Hardy 1977, 1982, 1983). The biogeographical implications of these distributions, and the exact relationship of *Centrolenella orientalis tobagoensis* to *Centrolenella orientalis orientalis* will not be understood until more material is available from Venezuela and until biochemical differences (or similarities) between these various disjunct populations have been documented and critically analyzed.

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NEWS AND NOTES:

THE HERPETOLOGICAL WORKS OF JACOB KLEIN,
WITH EMPHASIS ON THEIR PERTINENCE TO MEXICAN HERPETOLOGYAbstract

The works of Jacob Theodore Klein are reviewed with attention to their contribution to the field of herpetology in general and Mexican herpetology in particular. With the exception of coinage of the word herpetology (although defined differently from at present), his labors now seem an exercise in futility, although they undoubtedly served a useful purpose in their own era in channelling the efforts of others in more fruitful directions.

Jacob Theodore Klein (1685-1759) is today little known, at least in the Americas, yet was one of the most prolific naturalists of his era. He wrote at least 24 different books on diverse organisms, appearing in a total of at least 31 different editions and printings. Separate books were published on botany, echinoderms, marine worms, molluscs, invertebrate fossils, geology, fishes, birds, limbless tetrapods, quadrupeds and reviews of Linnaean works, most of them synoptic of then current knowledge. It was an amazing output for his time and for leisure-hour pursuit, for as Secretary of the State of Danzig he had little spare time.

The seven works pertaining to amphibians and reptiles appeared between 1743 and 1760 (see Literature Cited). They were taxonomic in nature, listing species then known, or their classification, or both, with brief characterization. Two works of 1760 are postlinnaean, yet not a single name is now attributed to Klein, and his works served in no way as a source for others. The primary reasons for the total lack of nomenclatural impact of his publications are (1) the almost exclusively compilatory nature of his writings, summarizing and to a certain extent analyzing the works of others, lacking any "primary" contribution whatever, and making only "secondary" innovations in arrangement and group names for species recognized by others (although he apparently did have a museum of his own, as indicated by the portrait serving as a frontispiece for his *Système Naturel* of 1754, showing specimens, including some bottled snakes and other herps, of various sorts); (2) the misfortune of being prelinnaean except for two posthumous works of 1760; (3) the failure to adopt consistently the principles of binomial nomenclature (required for any work officially admissible in biological nomenclature); and (4) the inconsistency of classificatory schemes adopted in his several works.

Indeed, perhaps at present Klein's greatest claim to fame in herpetology is his creation of that very word in his 1755 work, even though his "herpeta" (i.e., herpetozoans) embraced all limbless animals then known that have an elongate body and move sinuously (1755:1). That definition limited the coverage to snakes, "amphisbaenids" (including caecilians) and worms - the extremes of "creeping and crawling things," as implied etymologically. He thus thought of "herpeta" as the antithesis of "quadrupeda" or four-limbed animals, which he interpreted quite literally, not in the present "tetrapod" sense including all members of the classes Amphibia, Reptilia, Aves and Mammalia.

With the one exception, then, of creation of the word "herpetology," Klein's contributions are now lamentably of historical interest only. They are nevertheless a monument to industry and human frailty, and in their time undoubtedly served a useful purpose in exploring a trail whose destiny could not be anticipated but which in its dead end showed that the goal had to be reached some other way. Trial and error has always been the rule when the goal is clear but the route to it is unclear. Those who choose blind alleys often deserve as much homage as those who guess aright, for neither knows how their efforts will succeed; failures are often as important as successes, when learning results.

An over-all view of Klein's publications, from the earliest to the latest, gives a clear picture of the heroic struggle early workers endured in striving for the most "natural," meaningful classification of organisms. Klein in the end was convinced that superficial appearance and habitat were proper criteria for assumption of relationship - a perfectly reasonable conclusion on the premise of special creation that was then prevalent. Relationship through evolution and phylogeny was then dimly comprehended, or not at all; our present classification could stand on no other basis. Linnaeus suffered from the same misconception, but came closer to a true "natural" classification than Klein because of greater attention to details of structural similarity.

Klein's struggle in grappling with classification is evident also in the extensive inconsistency in application of names in various categories, from the highest to the lowest. Indeed, often names as such were not used, placing reliance instead upon a description. Generic names were not used throughout given genera, or different ones were used for the name in some cases. Species were not always given specific names, or even a brief polynomial, and sometimes were not even given the generic name. The idea of binomial nomenclature had not yet been adopted, and indeed all names and ranks seemed to be rather nebulous. (Thus the assignment of Klein's names to given ranks in the following accounts takes some liberties with his actual usages).

Despite these shortcomings in Klein's work, as seen in retrospect, we here seek belatedly to promote some of the attention that Klein's noble efforts deserve, by briefly reviewing all of his herpetological works of which we are aware, noting in the process their pertinence to Mexican herpetology.

1743

The earliest work pertaining to herpetology appeared in 1743 and was a tentative review, in Latin, of the higher categories of quadruped (the term being used in its literal sense, in reference strictly to four-footed animals) classification. The "Class Amphibia," embracing all amphibians and reptiles (pp. 25-30), was diagnosed, and two orders, Reptilia (with three "genera:" *Testudo*, *Rana* and *Lacerta*) and Serpentina (with one genus, *Anguis*), were all briefly discussed with passing mention of a few species and pertinent literature.

1751

The second work (1751:96-123) also is limited to quadrupeds, but with greater detail, listing all known species-group taxa. Again, "quadruped" is used in its literal sense, hence excluding snakes and other limbless tetrapods. The "Order Depilata" contained three divisions (rank not specified): Testudinata, Cataphracta and Nuda. All turtles (Testudinata) were placed in *Testudo*, a group presumably equivalent to a genus although the rank was not specified. The species of *Testudo* were placed in two groups—one with fused digits ("pedibus anomalis"), containing the sea turtles (three species), the other with digits distinct ("digitis discretis"), containing eleven species. One of the latter was presumably Mexican: "*Testudo ex nova Hispania*, sourced from "Seba, p. 129, pl. 80, fig. 5."

The crocodilians were subsumed under the "Cataphracta," and perhaps under one genus, "*Crocodylus*," but the species were poorly delimited; a *Crocodylus americanus* was recognized, another stated to be the alligator, and "*caimanos*" of diverse origins (Ceylon, Africa, America).

The "Nuda" embraced nine genera. *Lacerta*, by far the largest, contained 88 species, arranged in three groups (crestless, crested, salamander-like). At least twelve may be Mexican: (1) *Lacerta major*, supposedly the same as Hernández' (1648) "tilquetzpallin," sourced from "Seba, p. 152, pl. 97, fig. 2" (Smith, 1969:9, identified Hernández' species as *Sceloporus aeneus* and *S. grammicus*); (2) *Lacerta texiwincoyotl*, with a name derived from Hernández (1648), although not mentioned, but sourced from "Seba, p. 151, pl. 96, figs. 1-3" (Smith 1969:9, suggested that Hernández' species might be *S. jarrovi*); (3) *Lacerta de Taletec*, equated with Hernández' (1648) "tamacolin" (regarded by Smith, 1969:9, as any of several common species of anurans of the genera *Eleutherodactylus*, *Leptodactylus*, *Hyla*, *Scaphiopus* and *Bufo*), sourced from "Seba, p. 151, pl. 97, fig. 1; (4) *Lacerta Brazil*, included here only because it is given an Aztec name (quetzpaleo, not mentioned by Smith, 1969; perhaps a misspelling of "cuetzpallin," see no. 5), although without reference to Hernández, sourced from "Seba, p. 152, pl. 97, fig. 4;" (5) *Lacerta Mexicana Cutespallin* (=cuetzpallin of Hernández, 1648, but not mentioned; regarded as some species of *Sceloporus* by Smith, 1969:9),

sourced from "Seba, p. 152, pl. 97, fig. 5;" (6) *Lacerta Mexicana*, sourced from "Seba, p. 31, pl. 30, fig. 2;" (7) *Lacertus Americanus*, noted as one of the "iguanas," may be a Mexican species, sourced from "Seba, p. 149, pl. 95, fig. 1;" (8) *Lacerta Mexicana*, sourced from "Seba, p. 140, pl. 89, fig. 1;" (9) *Lacerta Mexicana*, called "tecoixin" (= tecuixin of Hernández, 1648, not mentioned, but regarded by Smith, 1969: 9, as any of several small species of *Sceloporus* or as *Urosaurus bicarinatus*), sourced from "Seba, p. 141, pl. 89, fig. 2;" (10) *Lacerta heliaca, Americana, pectinata*, may be Mexican (no indication of locality), sourced from "Seba, vol. 2, p. 169, pl. 106, fig. 2;" (11) *Lacerta Salamandrina, Salamandra Mexicana*, sourced from "Seba, p. 21, pl. 20, fig. 4;" and (12) *Lacerta Tapayakin*, or *Lacerta orbicularis* (= tapayaxin of Hernández, 1648, not mentioned; *Phrynosoma orbiculare* as long accepted, and as reiterated by Smith, 1969: 10), sourced from "Seba, vol. 2, p. 10, pl. 8, fig. 7."

Other genera recognized among Klein's "Nuda" were *Salamandra*, *Gekko*, *Cordylus*, *Scincus*, *Seps*, *Chamaeleo*, *Rana* and *Bufo*, among which only three species are possibly Mexican: (1) *Cordylus cauda bifurcata, Salamandra Americana*, sourced from "Seba, vol. 1, p. 173, pl. 109, fig. 5;" (2) *Chamaeleo Mexicanus*, or "Cuapapalcatl" (= quapapalcatl of Hernández, 1648, not mentioned; usually regarded as *Corytophanes hermandezii* fide Smith, 1969: 6, 13), sourced from "Seba, p. 132, pl. 82, fig. 1;" and (3) *Rana marina, Americana*, perhaps from Mexico (locality not indicated), but almost certainly the species commonly regarded as *Bufo marinus* (alternatively, in Mexico, as *Bufo horribilis*), sourced from "Seba, p. 120, pl. 76, fig. 1."

1754a

This work is a translation into French of the 1743 book. The section on amphibians and reptiles (pp. 47-56) contains virtually the same material as the earlier work; the names are mostly in the French vernacular, however -- the "generic" names of *Testudo*, *Rana* and *Lacerta* do not occur.

1754b

The greatest of Klein's works is his "Système Naturel du Regne Animal" which was put forth as the equivalent of Linnaeus' "Systema Naturae," as suggested by his subtitle for the first of the two volumes: "Containing the Classes of Quadrupeds, Birds, Amphibians, according to the method of M. Klein; with a notice of that of M. Linnaeus for the same animals; and the Order of Fishes according to the arrangement of Artedi." The frontispiece is a stylized portrait of Klein in his imposing study-museum (Fig. 1).

The organization of amphibians and reptiles (as now understood) does not, however, follow the pattern implied by the volume's subtitle; only two orders were recognized: (1) the Reptilia, including turtles, anurans, crocodilians, salamanders and lizards, and (2) the Serpens,

including caecilians, amphisbaenids and snakes. Ten genera were recognized in the Order Reptilia: *Testudo*, *Rana*, *Bufo*, *Crocodilus*, *Lacerta*, *Salamandra*, *Cordylus*, *Scincus*, *Sebs* and *Cameleo*, five with species of probable Mexican origin. However, the frequent early French practice of eschewing Latin names for animals, in favor of vernaculars, was followed more or less consistently throughout; their use appears to have been incidental.

The genus *Testudo* was divided into two groups of species, much as in his 1751 work, but none was attributed specifically to Mexico. The only species mentioned that do occur there are the sea turtles; their accounts are, however, difficult to assign to species, especially since the seven (or eight) accounts are in part just references to figures or descriptions in the literature without assignment to species (e.g., no. 6 states "Seba, p. 127, pl. 79, figs. 4, 5, 6, 7, gives a figure of three small sea turtles.").

Under the genus *Rana* only *R. marina Americana* was mentioned, with the same source given in his 1751 work, but with only "American sea" as a locality.

In *Bufo*, however, two species, "*B. Brasiliensis*" and *B. B. orbiculatus*" (nos. 2 and 8 respectively) were treated, both stated to be from Brazil, but given the vernaculars of "aquaqua" and "aquaquaquan," respectively. Those are names derived from Hernández (1648), although not so stated. The first was identified by Smith (1969: 5) as *B. marinus*, but the second name was not found in Hernández' work and may therefore be a variant created by Klein. They were sourced from "Seba, p. 114, pl. 71, figs. 6, 7" and "Seba, p. 116, pl. 73, fig. 1," respectively. Hence the same species, *Bufo marinus*, was entered under at least two different names, in different genera, in this work - a not surprising error in view of the rather crude drawings Klein attempted to deal with.

The third genus, of "lizards," was divided into two sections, one including crocodilians, the other true lizards. The first section included three American species, all occurring in Mexico although that country was not mentioned. One, referred to as *Crocodilus Americanus* (Seba, p. 167, pl. 106, fig. 1) is presumably *Crocodylus acutus*; the "Crocodile des Indes Occidentales," or "Alligator," sourced from Catesby, is certainly *Alligator mississippiensis*; and his "Caimans," from "Ceylon, Africa and America" (Seba, vol. 1, pls. 103-105, fig. 3) presumably included the genus *Caiman* as now known.

The second division of "lizards" contains the same fourteen species from Mexico, or possibly from there, as noted in his 1751 work in the genera *Lacerta*, *Cordylus* and *Cameleo*, although Latin names were not used for most of them in the 1754 work.

In the Order Serpens, six "genera" are treated, but none is given an explicit name. The kinds of animals recorded in the literature that are assignable to each genus are listed, and names used by the cited authors

are usually given, but one is left in the dark to know what Klein would call them. The first genus consisted of two species of ichthyophiid caecilians, for which other authors used the name *Cecilia*. The same ten species of the second genus, defined as having grooves around the body, also consisted of caecilians, of families other than the Ichthyophiidae, and of some amphisbaenians, none clearly from Mexico.

The third genus consisted of some seven species with small scales on the abdomen, but no grooves around the body. Species referred by others to *Cecilia*, *Amphisbaena* and *Scytale* are included; one of the latter name is listed for "New Spain" (= Mexico), sourced from "Seba, vol. 2, p. 4, pl. 2, figs. 3, 4" (see no. 23 in the following account of the Tentamen Herpetologiae).

The fourth genus consisted of 27 numbered species, as well as some 25 merely listed from Seba. The genus was characterized as having strap-like ventral scales, and judging from the names used by other authors included species of the families, as now understood, Colubridae, Elapidae and those Viperidae with large head scales. Genera cited from other authors include *Coluber*, *Naia*, *Sibon*, *Ahaetulla*, *Petola*, *Malpolon* and *Vipera*. Nine "species," to judge by name or locality citation, were from Mexico: (1) a "cencoatl" (= cencóatl), whose name originated with Hernández (1648), not mentioned, interpreted by Smith (1969: 5, 6, 7) as three different species (*Spilotes pullatus*, *Pituophis deppei* and perhaps some species of *Leptodeira*), but sourced from Linnaeus' *Systema Naturae* and from Seba, vol. 2, p. 18, pl. 16, figs. 2, 3; (2) an "apachycoatl" bearing an Aztec name, but not cited in Hernández; we assume it is a Mexican species, sourced from four different works, including Seba, vol. 2, p. 21, pl. 20, fig. 1; (3) a spectacled snake from New Spain, sourced from Seba, vol. 2, pl. 97, fig. 4; (4) another "cencoatlt" (= cencóatl), sourced from Seba, vol. 2, pl. 26, fig. 1; (5) a "tetzauchcoatlt" (= tetzauhcoatl), stated to be from Brazil, but bearing an Aztec name, hence probably from Mexico; Hernández (1648) used the name for only one snake, apparently a *Geophis* (Smith, 1969: 9), although the same name was applied to skinks and *Bipes*, neither of which could figure in Klein's "Serpens;" sourced from Seba, vol. 2, pl. 77, figs. 2, 3, pl. 79, fig. 12, and pl. 80, fig. 1; (6) a "tlehua," which name Hernández (1648, not mentioned) applied to a rattlesnake, perhaps *Crotalus polystictus* (Smith, 1969: 8), but certainly not so intended by Klein, who put rattlesnakes in another (the sixth) genus; sourced from Seba, vol. 2, pl. 59, fig. 1; (7) another "tlehua," from New Spain, sourced from Seba, vol. 2, pl. 84, fig. 1 (assigned to a "Petzcoal" also in the incertae sedis; see no. 7 of that list, following); (8) a "xalxalhua" (= xaxalhua) from Mexico, regarded as *Pseustes poecilonotus* by Smith (1969: 9), as the name was used by Hernández (1648) (not mentioned), but sourced from Seba, vol. 2, pl. 77, figs. 4, 5; and (9) a "depone" (= dopone of Hernández, 1648, not mentioned), from Mexico, regarded as *Oxybelis fulgidus* by Smith (1969: 11), but sourced from Seba, vol. 2, pl. 61.

Klein's fifth genus of "Serpens" was characterized as having large ventrals, small head scales and no rattles. Some fourteen "species" were included, mostly viperids (as now understood), but apparently also the boids. One snake from Mexico was cited, sourced from Seba, vol. 2, p. 104, pl. 98, fig. 1.

The sixth genus contained the rattlesnakes, of perhaps seven species, among which Hernández' (1648) "teuhtlacet-zauhqui" (= teuhtlacoauhqui) from Mexico was cited. That name was interpreted by Smith (1969:8) as referring to *Crotalus basiliscus* and *C. durissus*. No other source was cited by Klein for that species (although in the Tentamen of 1755 this name was sourced from Seba, pl. 95, fig. 2, referred in 1754b to "*Serpens crotalophora*" of America).

Following the accounts of these six genera, Klein listed 91 figures from Seba of snakes he could not place in his "system;" they were incertae sedis, and among them are at least eight from Mexico: (1) the "ataligato" of Mexico, characterized in Hernández (1648) by "a totally implausible fable" (Smith, 1969:10), sourced from Seba, vol. 2, pl. 77, fig. 6; (2) "chiametla," from "America," sourced from Seba, vol. 2, pl. 61, fig. 4, which serves as the type for *Coluber chiametla* Shaw, 1802, a senior synonym of *Drymobius margaritiferus* (Schlegel, 1837), but suppressed by the International Commission on Zoological Nomenclature in Opinion 1246 (1983) (see also Smith, 1965 and 1967, and Smith and Smith, 1979); (3) an "emperor of Guadalajara," from Mexico, revered for foretelling the future, sourced from Seba, vol. 2, pl. 1, fig. 1; (4) the "macacóatl," from "America," using Hernández' (1648, not mentioned) name which (Smith, 1969: 7) applied to *Boa constrictor*, but sourced from Seba, vol. 2, pl. 79, fig. 3; (5) a "macoatl," which probably refers to the "second" "macacoatl" of Hernández (1648, not mentioned), from Mexico, sourced from Seba, vol. 2, pl. 73, fig. 1; (6) a "ninboo-quanque cholla," from Mexico, sourced from Seba, vol. 2 pl. 77; (7) a "petzcoal" (= petzcóatl) from Mexico, using Hernández' (1648, not mentioned) name, which Smith (1969:8) regarded as possibly *Dermophis mexicanus*, but sourced from Seba, vol. 2, pl. 84, fig. 1, and certainly there not a caecilian; and (8) the "tamacailla-huilia" from Mexico (= temacuilcahuilia of Hernández, 1648, not mentioned, which Smith, 1969:10 regarded as strictly a fable), but sourced from Seba, vol. 2, pl. 98, fig. 1 (the same source that was used for the Mexican species of his 5th genus; see preceding).

1755

The "Tentamen Herpetologiae" is written entirely in Latin, and is of special interest as the first published, strictly herpetological synopsis, although Klein's interpretation of the word differs extensively from its current meaning. It is thus a landmark of sorts in the field, yet is quite a rarity: of the over 750 U.S. institutions cooperating in compilation of the National Union Catalog of Pre-1956 Imprints, only six reported having a copy (Amherst, Boston Public, Cornell, Library of Congress, University of California at Berkeley, Yale). Another copy is in the personal library of Kraig Adler, and we possess two.

Special attention should be directed to the strangest inclusion of the Tentamen: the only figure of a reptile occurring in it: a fantastic, mythical lizard on pl. 1, shown with a cylindrical body, two powerful, 4-toed hind legs, no forelegs, a stout tail little longer than body, a somewhat skinklike head and well-developed eyes (Fig. 2). It is like no known animal. The only reference to it (p. 50) indicates that it was sourced from a book, "*Thesaurus animalium vivis coloribus egregie pictorum*," formerly possessed by "Jobus Lodolphus" (= Hiob Ludolf, 1624-1704), and that he was uncertain of its proper classification. The animal was not described or illustrated in any of Ludolf's works, all of which listed in the National Union Catalog we have checked; the book referred to in Ludolf's library was certainly by some other author, and its identify we have not been able to determine. That the animal (mythical, certainly) was an exasperating *incertae sedis* for a system of classification recognizing only quadrupeds and limbless "herpeta" is readily understandable.

Klein placed his "herpeta" (i.e., herpetozoons, as he interpreted them) in two orders: reptiles in the Order *Anguis*, worms in the Order *Vermis*, thus differing markedly from his "system" of the previous year.

Little space was allotted to the Order *Vermis* - only pp. 58-72. Only a little more than one page (55-56) was devoted to "amphisbaenids" (which included some caecilians), hence the bulk of the text concerns snakes.

The treatment of *Vermis* is also strange. There is a brief account of three "classes" (given a lower rank than Order) - *Lumbricus*, *Taenia* and *Hirudo* - with the account ending on p. 66, followed by the two plates and an article (pp. 67-72) by J. A. Unzer on "*Observatio... de Taeniis*." All figures (8) on pl. 2, and all but one of the figures (4) on pl. 1 represent the anatomy of parasitic worms (nematodes), accompanying Unzer's article (see his obscure references to those figures on p. 70).

Klein's "Order" *Anguis* was credited with two "classes," neither designated uninominally. The first class, by far the larger, was described as having a distinct head and tapering tail, the second class an indistinct head and blunt tail. The latter class contained two genera - *Scytale* and *Amphisbaena*, with 17 and 15 species respectively. The first class was regarded as containing three genera: *Vipera*, with in effect four subgenera (one the equivalent of viperids as now known, excluding rattlesnakes; one for the rattlesnakes; one for elapids as now known; and one for "vipers" lacking enlarged teeth, hence actually a mixture of non-poisonous snakes), totalling 78 species; *Coluber*, with 165 species arranged in eight groups of seemingly lesser rank - perhaps similar to species-groups - than those of *Vipera*; and *Anodon*, a supposedly edentulous genus of five species.

The account for the first class terminates with a listing of 14 species of snakes described by Catesby and 33 by Linck. These 47 were regarded by Klein as essentially incertae sedis, along with the two-legged monstrous lizard illustrated on pl. 1.

The species accounts are numbered consecutively in each genus or subgenus. They are brief, of but a few lines, but usually include some sort of characterization, often a locality, and always a source citation from the literature - usually Seba but occasionally some other - and authority. Many of the species accounts have a marginal rubric giving the species name, in much the same style as Linnaeus' *Systema Naturae*, although nowhere is that work mentioned in the account of members of his Order Anguis, although frequent references occur in the accounts of members of his Order Vermis.

Each of the higher categories is provided with a characterization, and sequentially lettered footnotes (from a to Zzz) at the end of each section give additional information widely representative of the literature.

Twenty-four species presumably or certainly from Mexico are treated.

(1) *Vipera depone*, p. 9, no. 13, was sourced from "Seba, pl. 92," hence is not the same as the "depone" of his 1754(b) work (see *Coluber pullatus*, no. 13 of the following accounts), nor is it Hernández' (1648, not mentioned) "dopone," from which the name was derived, as interpreted by Smith (1969:11), to wit *Oxybelis fulgidus*.

(2) *Vipera crotalophora*, p. 16, no. 4, was designated "teutlacot-zouphi," also cited in his 1754(b) work, but in the Tentamen the source was specified as "Seba, pl. 95, fig. 2." The name was clearly derived from Hernández' (1648, not mentioned) "teuhtlacoauhqui," identified by both Dugès (1889) and Smith (1969) as *Crotalus basiliscus* or *C. durissus*.

(3) *Vipera conspicillaris altera*, p. 18, no. 12, from New Spain, sourced from Seba, pl. 97, fig. 4, is the same as the "spectacled snake" listed in the 1754(b) work, mentioned in the preceding account as the 3rd species in the 4th genus.

(4) Ecacoatl, p. 17. A footnote referring to an account on p. 16 of the rattlesnake "subgenus" ("Caudisona, Americana") of *Vipera* describes in considerable detail the Ecacoatl, from several sources, none of them Seba or Hernández. The latter author is, however, presumably the ultimate source for the name. His ecacóatl was described as a large, 7-striped snake of several colors, interpreted by Smith (1969) as *Masticophis taeniatus*. Obviously Klein had as much difficulty distinguishing venomous from non-venomous species as Hernández did.

(5) *Vipera rietu canino*, p. 19, no. 3, was named the "tetzauhcoatl," but was sourced from a single plate in Seba (80, fig. 1) rather than the three cited for the same name in his 1754(b) work. In the latter work the species was cited for Brazil, but in the Tentamen another Brazilian

species, "*V. thalassina*," is given the same name (spelled "tetrauchoatl," but sourced from a plate in Seba (96, fig. 2) still different from any of the three cited for the species in his 1754(b) work. See preceding discussion.

(6) *Vipera oculea*, p. 20, no. 8, was called "tamacuilla huilia," which name was sourced from Hernández' (1648, so specified) "temacuilca-huilia," interpreted by Smith (1969) as strictly fictitious. As in Klein's 1754(b) work, the species was sourced from Seba, pl. 98, but cited in both the 5th genus and in the incertae sedis (no. 8 of that list in the preceding account).

(7) *Vipera divinatorix* and *imperatrix regni Mexicani*, p. 20, no. 11, is the same snake referred to in the 1754(b) work as the "emperor of Guadalajara (misspelled Quadalajara in both works). See preceding discussion. Interestingly, the names *imperator* (of Daudin, 1803) and *diviniloquax* (*diviniloquus* Laurenti, 1768) have long been recognized as junior synonyms of *Boa constrictor*, a subspecies of which, occurring in Mexico, is still known as *imperator*.

(8) *Coluber apachykoatl*, p. 25, no. 3, is the same as the snake bearing the same specific name in the 1754(b) work. See preceding discussion, to which nothing can be added from the Tentamen.

(9) *Coluber mexicanus*, p. 26, no. 13, was sourced from Seba, pl. 30, fig. 1. Its identify is uncertain.

(10) *Coluber xaxalhua*, p. 31, no. 56, is identical with the "xaxalhua" of the 1754(b) work; see preceding discussion.

(11) *Coluber tlehua*, p. 31, no. 57, is the same as the second "tlehua" of the 1754(b) work, sourced from Seba, vol. 2, pl. 84, fig. 1 (which was in 1754b also the source for the "petzcoal" of the incertae sedis). The footnote (tt) on p. 32 merely states that *Vipera flammea* of the literature is not the same. See preceding discussion.

(12) *Coluber margariticus*, p. 33, no. 68, was not included in the 1754(b) work, but although lacking any locality citation, is here included since it apparently is *Drymobius margaritiferus* (Schlegel, 1837), a species widespread in Mexico. It was sourced from "Seba, pl. 22, fig. 2."

(13) *Coluber cencoatl*, p. 34, no. 70, has the same source as the second "cencoatl" of the 1754(b) work. As noted previously, the name was used by Hernández (1648) for at least three species; very likely *Pituophis deppei* is the one to which this account refers.

(14) *Coluber chiametla*, p. 38, no. 121, is the same as the "chiametla" of the 1754(b) work; see preceding discussion.

(15) *Coluber pullatus*, p. 38, no. 122, is the "depone" of the 1754(b) work, being based on Seba's vol. 2, pl. 61, fig. 2. The name presumably pertains to the species now known as *Spilotes pullatus*.

(16) *Coluber petlacoatl*, p. 38, no. 123, sourced from Seba, pl. 63, fig. 1, was not mentioned under that name in Hernández (1648), nor in the 1754(b) work, although a "petzcoal" was listed there (see preceding discussion), sourced from Seba, vol. 2, pl. 84, fig. 1, which in the Tentamen was assigned to *Coluber tlehua* (no. 11 above), and in the 1754(b) work to the second *tlehua* (no. 7 of that account, under the 4th genus).

(17) *Coluber ataligato*, p. 40, no. 138, is the same as the "ataligato" of the 1754(b) work (see discussion above of the incertae sedis, no. 1, of that work).

(18) *Coluber macacoatl*, p. 40, no. 139, is the same as the "macacoatl" of the 1754(b) work (see discussion above of the incertae sedis, no. 4, of that work).

(19) *Coluber capitali fascia latiore*, p. 40, no. 139, sourced from Seba, pl. 80, fig. 2, from "New Spain," may be *Coniophanes imperialis*. The 1754(b) work lists this figure as the source for an incertae sedis, "Bayhapua," an African snake.

(20) *Coluber petzcoatl*, p. 40, no. 143, sourced from Seba, pl. 84, fig. 2, is not the same as the "petzcoal" of the 1754(b) work (Seba, pl. 84, fig. 1). The Tentamen species is arboreal, perhaps *Oxybelis aeneus*.

(21) *Coluber cencoatl*, p. 41, no. 158, was perhaps intended to be the same as the first "cencoatl" of the 1754(b) work (see no. 1 of the 4th genus in account for that work), but it actually is sourced from Seba, pl. 16, fig. 1, rather than from figs. 2 and 3.

(22) *Coluber tetzauhcoatl*, p. 42, no. 165, was sourced from Seba, pl. 77, figs. 2, 3, one of three sources given in the 1754(b) work for the "tetzauhcoatl" of the 4th genus (see no. 5 under that genus in preceding account). Why this snake, bearing a name derived from Hernández (1648, not mentioned), was stated to be from Brazil is uncertain.

(23) *Scytale ex nova Hispania*, p. 53, no. 5, sourced from Seba, pl. 2, figs. 3, 4, is of uncertain identity.

(24) *Scytale nixboa quanquecholla*, p. 54, no. 14, sourced from Seba, pl. 77, fig. 1, is the same as the "ninboo-quanque cholla" of the incertae sedis (no. 6 in the preceding account) of the 1754(b) work. Hernández' (1648) "nexoa" was undoubtedly the source of Klein's names "nixboa" and "ninboo." Smith (1969: 10) interpreted Hernández' species as *Masticophis flagellum*, known to occur in the vicinity of Huauquechula (whence presumably Klein's "Quanquecholla"), Puebla.

Numerous discrepancies exist between the 1754(b) and 1755 works, in the areas of overlap, as might well be expected since the latter is much more detailed. A number of differences have been noted in the preceding discussion, but others should be noted. Four "species" of the 1754(b) work are not dealt with in the later review, and seven of the latter are not noted in the former. Omitted in 1755 are: (1) an allocation of the Seba, pl. 16, fig. 3, one of the two sources for the 1754(b) "cencoatl" (4th genus, 1st species of account herewith); two *Coluber cencoatl* species were included in the Tentamen, but neither sourced from Seba, pl. 16, figs. 2 and 3 that were the basis for the 1754(b) "cencoatl;" the fig. 3 of pl. 16 in Seba was in 1755 used as the source for *Coluber coyuta* of Brazil; (2) the "tlehua" based on Seba, pl. 59, fig. 1 (the *Coluber tlehua* of 1755 was sourced differently); (3) the "macoatl" based on Seba, pl. 73, fig. 1; and (4) an allocation of Seba, pl. 79, fig. 12, which in 1754(b) served as one of the three sources for the second "cencoatl" (the other two were allocated to *Vipera riotu canino* and *Coluber tetzauhcoatl*).

The species of the Tentamen not represented in the System are (1) *Vipera depone* of Seba, pl. 92 (the 1754(b) "depone" has a different source); (2) *Coluber petlacoatl* of Seba, pl. 63, fig. 1 (the 1754(b) "petzcoal" has a different source, allocated in 1755 to *Coluber tlehua* and in 1754(b) used as the source also for the second "tlehua"); (3) *Coluber capitali fascia latiore* of Seba, pl. 80, fig. 2; (4) *Coluber petzcoatl* of Seba, pl. 84, fig. 2 (that figure served in the 1754(b) work as the source for an African snake, "bayhapua;" the "petzcoal" of 1754(b) was based on Seba, pl. 84, fig. 1, which served as source also for the second "tlehua" of that work, and for *Coluber tlehua* of 1755; (5) *Coluber cencoatl* of Seba, pl. 16, fig. 1 (two "cencoatl" species were included in the 1754(b) work, but neither was based on this figure); (6) *Coluber margariticus* of Seba, pl. 22, fig. 2; and (7) *Coluber mexicanus* of Seba, pl. 30, fig. 1.

1760a

This book is a translation into German of the 1751 volume, hence with the same content. The herpetological pages extend from 285 to 381.

1760b

This work likewise is a translation into German of the 1751 Latin discourse, and is not binomial in its nomenclature. A few annotations not in the original Latin have been added, but the organization and taxa are the same. The herpetological pages extend from 105 to 131.

Summary

The seven works by Jacob Theodore Klein that pertain to herpetology have no taxonomic importance, most of them being prelinnaean and the two postlinnaean works being non-binomial and therefore not acceptable, according to the International Code of Zoological Nomenclature, for use in nomenclature. The herpetological accounts were drawn from the literature, with greatest reliance upon volumes one and two of Seba (1734-1735), but including also early editions of Linnaeus' *Systema Naturae* and several other prelinnaean works. His survey of the literature was thorough, and his classification at higher category levels was to a considerable extent original and unique. It was however handicapped by predication on superficial similarities gleaned from descriptions, without the benefit of insights resulting from study of the animals themselves.

His analyses did however lead to creation of the word "herpetology," although with a distorted understanding that combined snakes, legless lizards, amphisbaenids, caecilians and worms as related groups on the superficial bases of common possession of an elongate body, absence of limbs, and movement by sinuous undulation. Herpetozoons were thus thought of by Klein as the counterpart of quadrupeds, among which he recognized turtles, anurans, salamanders, lizards and mammals.

Klein's "system" of classification was, therefore, spurious - a blind alley in the evolution of understanding of the animal kingdom. Having been devised, however, it served to direct the efforts of others into more fruitful channels.

Considerable variation in higher-category terminology existed in comparison of early and late works, and even greater confusion is evident in the lower categories. An examination in some detail of the 45-50 "species" noted for Mexico reveals very nebulous concepts tied to often crude or imaginary descriptions and figures in the literature. Klein's works added nothing to an understanding of the Mexican herpetofauna, and indeed clouded the picture. No reason exists to think that the treatment of other herpetofaunae was any better.

Hence Klein's herpetological contributions remain strictly of historical interest, even though his obviously prodigious struggle to discern realities of classification deserve admiration. At least herpetologists of today and the future properly should be conscious of the fact that Jacob Theodore Klein was the "father" of the name for their discipline, and they can be grateful for that detailed unique illustration of the bizarre, mythical, "duobus pedibus lacertinis."

Acknowledgments

We are greatly indebted to Dr. Kraig Adler for counsel and for xeroxes of the herpetological sections of Klein's works of 1751 and 1754. Dr. Michael Preston kindly helped with translation of Latin passages of critical importance.



SYSTEME NATUREL
 D U
 REGNE ANIMAL,

PAR
 CLASSES, FAMILLES OU ORDRES, GENRES ET ESPECES.
 AVEC
 UNE NOTICE DE TOUS LES ANIMAUX;
 Les noms Grecs, Latins, & vulgaires, que les Naturalistes
 leur ont donnés;
 Les citations des Auteurs qui en ont écrit;
 Une Table pour chaque Classe, qui designe la Famille ou l'Ordre, le Genre
 & l'Espèce, de chaque Animal.
 Ouvrage enrichi de Figures en taille-douce.
 TOME PREMIER.

CONTENANT les Classes des QUADRUPÈDES, OISEAUX,
 AMPHIBES, suivant la méthode de M. KLEIN, avec une
 Notice de celle de M. LINNÆUS sur ces mêmes Animaux;
 Et l'Ordre des POISSONS suivant la division d'ARTEDI.



A PARIS,
 Quay des Augustins,
 Chez CL. J. B. BAUCHE, Libraire, à Sainte Geneviève,
 & à S. Jean dans le détroit.
 M. DCC. LIV.
 AVEC APPROBATION ET PRIVILEGE DU ROI.

Figure 1. Frontispiece from Klein's "Système naturel...",
 constituting a self-portrait and depiction of part
 of his library and museum.



Figure 2. "Duobus pedibus lacertinis" of plate 2 of Klein's
 "Tentamen herpetologiae." See text for explanation.

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and Rozella B. Smith

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Phyllis, Phallus, Genghis Cohen, & Other Creatures I Have Known is a humorous account of the author's 10 years in veterinary practice in Berkeley in the 1960's and '70's. Dr. Frye's specialty is reptiles (a herpetologist is not someone with herpes, he is quick to point out), and this led to some memorable encounters!

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The book is 414 pages, 8½ x 11 inches (21.5 x 28 cm), bound in buckram, price US \$45. A special leatherbound patron's edition, in two volumes, is US \$300. A four-page ad with sample color plates was published in the December 1982 issue of *Herpetological Review*, and copies may be obtained on request from Dr. Douglas H. Taylor, Department of Zoology, Miami University, Oxford, Ohio 45056, USA.

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The Maryland Herpetological Society

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CRYPTIC SPECIES IN THE
MEXICAN LIZARD COMPLEX,
Sceloporus aeneus

Louis J. Guillelte, Jr. and Hobart M. Smith

Abstract

The taxonomy of the reproductively bimodal lizard *Sceloporus aeneus* is examined. Morphology, karyotype, distribution, habitat and reproductive cycle data are used to clarify the phylogenetic relationship between the two taxa formerly referred to as *S. aeneus aeneus* and *S. aeneus bicanthalis*. These data show that the taxa are distinct in canthal number, reproductive mode, and reproductive cyclicity, and can be partially distinguished by ventral coloration. Some overlap in distribution may occur, but no hybrids were found. We conclude that these populations represent at least two separate, distinct, cryptic species, properly designated as *Sceloporus aeneus* and *Sceloporus bicanthalis*. Extrapolation leads us also to the tentative proposal that *S. subniger* is also a full species, subject to confirmation by future studies.

Sceloporus aeneus Wiegmann, 1828, is a small, terrestrial lizard found primarily at high elevations in southern Mexico (Smith, 1939). It inhabits the bunch grasses (*Muhlenbergia*, *Festuca*) associated with pine and pine/oak forests. Smith (1937) distinguished two subspecies based on consistent morphological differences in canthal number and coloration. *Sceloporus a. bicanthalis* was regarded as inhabiting primarily the eastern end of the Mexican transvolcanic mountains, *S. a. aeneus* the central part. However, Thomas and Dixon (1976) concluded that the putative subspecies are untenable, as they did not find consistent morphological differences.

Little was known of the life history of this lizard until recently. The species had been assumed to be viviparous since 1939 (Smith, 1939: 356), the evidence for *S. a. bicanthalis* being conclusive although none existed for *S. a. aeneus*. With elimination of subspecific differentiation in 1976, viviparity for the species as a whole seemed incontrovertible.

Recently, however, it was discovered (Guillelte, 1981a) that the then supposedly monotypic *S. aeneus* exhibits reproductive bimodality. That is, the more eastern populations are viviparous, the more western ones oviparous. In addition to parity bimodality, distinct morphological differences in the reproductive anatomy exist as well as a difference in the timing of reproductive activity (Guillelte, 1981b, 1982). Definitive confirmation of parity bimodality and apparent temporal reproductive isolation raises again the question of existence of two taxa in the supposedly single, monotypic species.

Key Words: Reptilia, Iguanidae, taxonomy, reproductive biology, *Sceloporus*, *S. aeneus*, *S. bicanthalis*, *S. subniger*.

The following study was undertaken to resolve that problem, utilizing distributional, morphological, and karyological data, as well as information in other studies, especially those concerning reproductive cyclicity (Guillette, 1981b, 1982). In the following discussion, we refer to the viviparous populations as "bicanthalis," the oviparous ones as "aeneus," without implication of taxonomic status - as subspecies, species or nontaxonomic - hence deferring that decision to the conclusion.

Materials and Methods

Study material was obtained from a number of areas surrounding the Valley of México. Viviparous populations were found at (Figure 1) (1) Parque Nacional de Zoquiapan, México (3000 m); (2) San Rafael, México (3000 m); (3) Paso de Cortés, Volcán Popocatepetl, México (3500 m); and (4) Nevado de Toluca, México (3850 m). Oviparous populations were sampled from (5) 15 kilometers south of Milpa Alta, Distrito Federal (2700 m); (6) Lagunas de Zempoala, Morelos (2900 m); (7) Tres Cumbres, Morelos (2900 m); (8) El Capulín, Distrito Federal (3000 m); and (9) Villa del Carbón, México (2600 m). Additional specimens were obtained on loan from the following museums: AMNH, USNM, MCZ, TCWC, UIMNH, UMMZ, KU, UCM, IBUNAM (acronyms from list compiled by SSAR Museum Acronym Committee, 1980).



Figure 1. Sites used during the study of the lizard complex, *Sceloporus aeneus*. Numbers correspond to those in text. Shaded areas represent those regions having an elevation of 2500 m or higher.

The following data were obtained from each museum or live specimen: (1) location of capture, (2) number of canthals, and (3) ventral coloration. Live specimens also were examined for coloration, scaled after Smithe (1975). Each color reported was a focal point of a range around that score.

Temperature, precipitation and ground cover density were recorded for field samples. Temperature and precipitation data were obtained from official records of the Dirección de Climatología, Secretaría de Recursos Hidráulicos, México (García, 1981). Ground cover density was estimated by a transect method. The center of each study site was located, and four transects were made from this point, running 25 m in each of the four cardinal directions. Ground cover was defined as anything providing cover from ground level to 15 cm. An average was obtained for each site, and then the means from all sites having the same parity type inhabitant were averaged. Percentage scores then were obtained by dividing the mean cover value by 25 m. A Student's T-test was performed to determine differences in cover density.

Karyotypes were obtained from five adult males of each parity type. Animals were collected in the field during May, 1980, and testicular material was treated using the methods of Cole and Leavens (1971). Cells were stained using Gelmsa, and the karyotype of five cells from each specimen was examined.

Results

1. Canthal Morphology.

All specimens of both sexes of "aeneus" had a single canthal on each side ($n = 375$), whereas all specimens referable to "bicanthalis" had two canthals ($n = 200$).

2. Color Patterns In "aeneus."

Female dorsal surface. Female "aeneus" exhibit a number of dorsal color patterns. In the normal pattern, a dorsolateral line of buff yellow to cream (Color Index = 2.5Y8.0/6.0-3.5Y8.5/4.0) runs from the rear of the head, level with the supratympanic area, to the tail, usually continuous along the 3rd and 4th scale rows (from midline). It is approximately one scale row wide, and may widen at midtrunk to two scales; widening, if present, is in a medial direction. The line crosses the sacral region onto the tail where it becomes darker and broader. It also may extend forward from eye to tip of snout. A second less distinct lateral line passes from the supralabial region through upper part of the external auditory meatus, over arm and along side of body to the groin; it is usually broken, follows the 8th and 9th scale rows at mid-body, covers half of each row and is one scale row wide. A vertebral grey line (CI = 7.5Y5.0/3.0) begins at nape of neck and usually occupies adjacent halves of the 1st pair of vertebral scale rows; it also may cover both rows completely, forming a line two scales wide. The region between the dorsolateral and vertebral lines is occupied by narrow, dark, dorsolateral cross bars. The background coloration is brown (CI = 7.5Y3.5/3.0), the cross bars dark brown (CI = 4.0R2.5/0.7), occupying 1-2

transverse scale rows, and sharply defined on posterior edge. Anteriorly the dark bars blend with intervening brown zones. The latter are 1.5 to 2.0 times the width of the dark brown bars; in some females the bars are edged posteriorly by white or cream; 11-14 bars occur between occiput and base of tail (mode = 12). Between the lateral and dorsolateral line similar lateral bars are present; they are not correlated with the dorsolateral bars. The lateral bars extend from one line to the other, and continue in series across the sacrum and onto the tail. In addition, a ventrolateral series of short bars, 1/2 to 1/3 the size of those in the other two series, borders the lateral line ventrally.

A light yellow (CI = 6.0Y8.5/12.0) suffusion extends from axillary region to mid-trunk; a black spot is present on the shoulder between the lateral line and white ventral surface. Centered in the black spot is a blue spot (CI = 10.0B3.8/11.0). The black shoulder spot is bordered on its anterior margin by a narrow, nearly vertical white line extending onto upper arm. A lateral gular light line extends from the lower labial region and under the auditory meatus to the shoulder patch. Limbs exhibit a barring similar to the dorsal trunk surface, with transverse light lines most noticeable on the posterior limbs.

Although in most females the dorsolateral and lateral bars are bordered posteriorly by white edging, in some it is reduced or absent. In some the background color is a grey brown (CI = 7.5YR4.5/5.0) instead of the normal light brown. About 20% of all the females obtained were nearly uniform dull tan (CI = 2.5Y6.0/2.4) or grey (CI = 6.0Y6.0/1.0), with little evidence of the usual pattern; the dorsolateral line is dimly evident in certain individuals, as are the vertebral line and dorsal barring. Notably, 58% of the females obtained from the Milpa Alta site exhibited the latter pattern. Here the animals live in a very sandy area with the lowest cover density value (34.8% cover) of any study site.

Female ventral surface. Melanophores are scattered over much of the ventral surface, with the throat and anterior thorax darker than the abdomen (Figure 2). The abdomen may have a bronze (CI = 5.0YR5.0/7.0), yellow (CI = 6.0Y8.5/12.0) or light blue (CI = 2.5PB7.0/7.0) color. In some cases, distinct lateral blue patches were observed and in some of the larger females the entire ventral surface was dark to black. Dorsally unicolor females were similar ventrally to patterned females. There appears to be no ontogenetic change in coloration of females.

Male dorsal surface. The lateral and lateral gular lines are prominent on the face of adult males. All body lines are less well defined than in females; in many they are virtually indistinguishable. Transverse dark bars are poorly defined and not edged posteriorly by white. The largest males appear very melanistic. The shoulder patch is prominent in all males; the blue center spot may be absent, and the ventral edge of the patch is bordered by a white line. The dorsolateral line is present between eye and tip of snout, but indistinct behind the eye; usually it is interrupted in the supratympanic area. Very distinct lateral patches of yellow (CI = 10.0YR8.0/14.0) or red (CI = 8.75R4.5/16.5) occur in some adult males; they may reach

as high as the dorsolateral line. Some exhibit no suffusion of such color, but no correlation of it with size, locality or reproductive activity is evident.

Male ventral surface. The throat is black or, in some, blue-black, up to the sides of the head and the lateral gular line (see Figure 2). Much variation is observed in the degree of white flecking, although it is always scattered and not arranged in bars. Males always exhibit denser pigmentation of the ventral surface than females. The dark abdominal pigmentation is bordered laterally by red, yellow or brown patches extending from axilla to thigh region, but not onto thigh or tail. Ventrolateral blue patches are evident in all individuals, but are hard to distinguish in those males having completely melanistic ventral surfaces. In extreme cases, the whole ventral surface from chin to thighs is black.

3. Color Patterns in "bicanthalis."

Female dorsal surface. The lateral, lateral gular and dorsolateral lines are present and similar to those observed in female "aeneus." The barring is similar except that the lateral series of bars does not extend to tail. In most individuals, the shoulder patch is not developed. The vertebral line is wider (3.4 scales wide) than in "aeneus." Unicolor females were not observed in any "bicanthalis" populations. In the Zoquiapan populations, a cinnamon (CI = 2.5YR5.0/8.0) background color was observed in approximately 5% of the females examined, replacing the light brown background usually evident. This color morph was not observed in any population of "aeneus," and was limited to associations in pine forests with little grass present but a thick carpet of dry pine needles.

Female ventral surface. Most females had a light blue (CI = 2.5PB7.0/7.0) abdomen; in some the blue was darker ventrolaterally (Figure 3). The throat in some females was barred lightly in black.

Male dorsal surface. The dorsal pattern is very similar to that of females of both subspecies. Very little sexual dimorphism occurs. In a few large males the pattern is reduced. In no male were the red or yellow lateral patches observed as seen in the "aeneus" males. The shoulder patches of "bicanthalis" are similar to those described for "aeneus" males.

Male ventral surface. The ventral pigmentation is less developed than in "aeneus" males (see Figure 3). Distinct ventrolateral blue patches (CI = 10.0B3.8/11.0) are present and the throat is diagonally barred in black and white (50:50); these bars may cover the thorax, abdomen and thighs.

4. Karyotype

No difference was observed in the karyotype of the two taxa. Both subspecies have a diploid chromosome number of 24 ($2N = 24$). The chromosomes are similar in size and shape. Additionally, both have a terminal satellite on the long arm of chromosome number two. These findings are similar to those reported by Cole (1978) for *S. aeneus*.

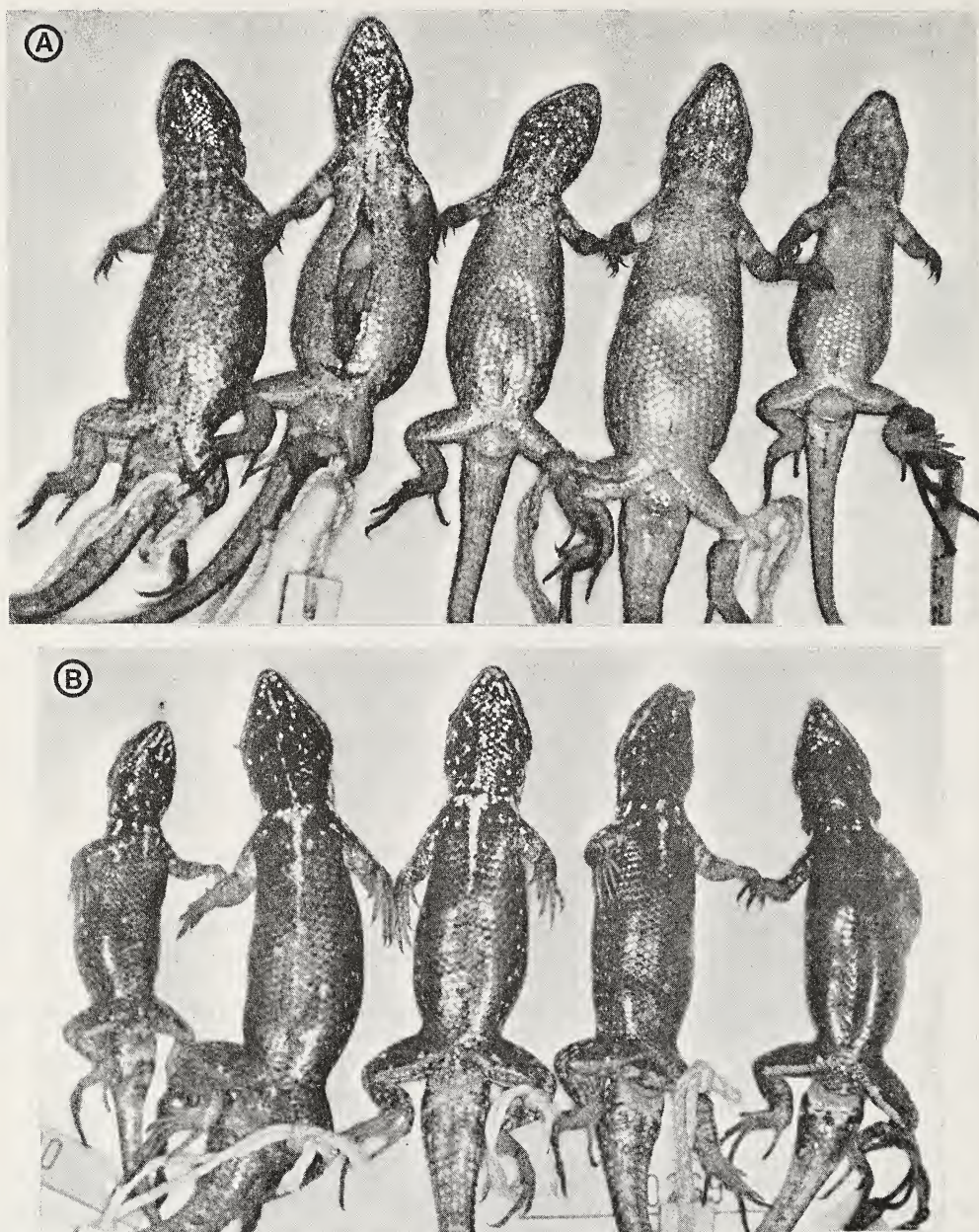


Figure 2. Ventral color pattern of female (A) and male (B) *Sceloporus aeneus*.

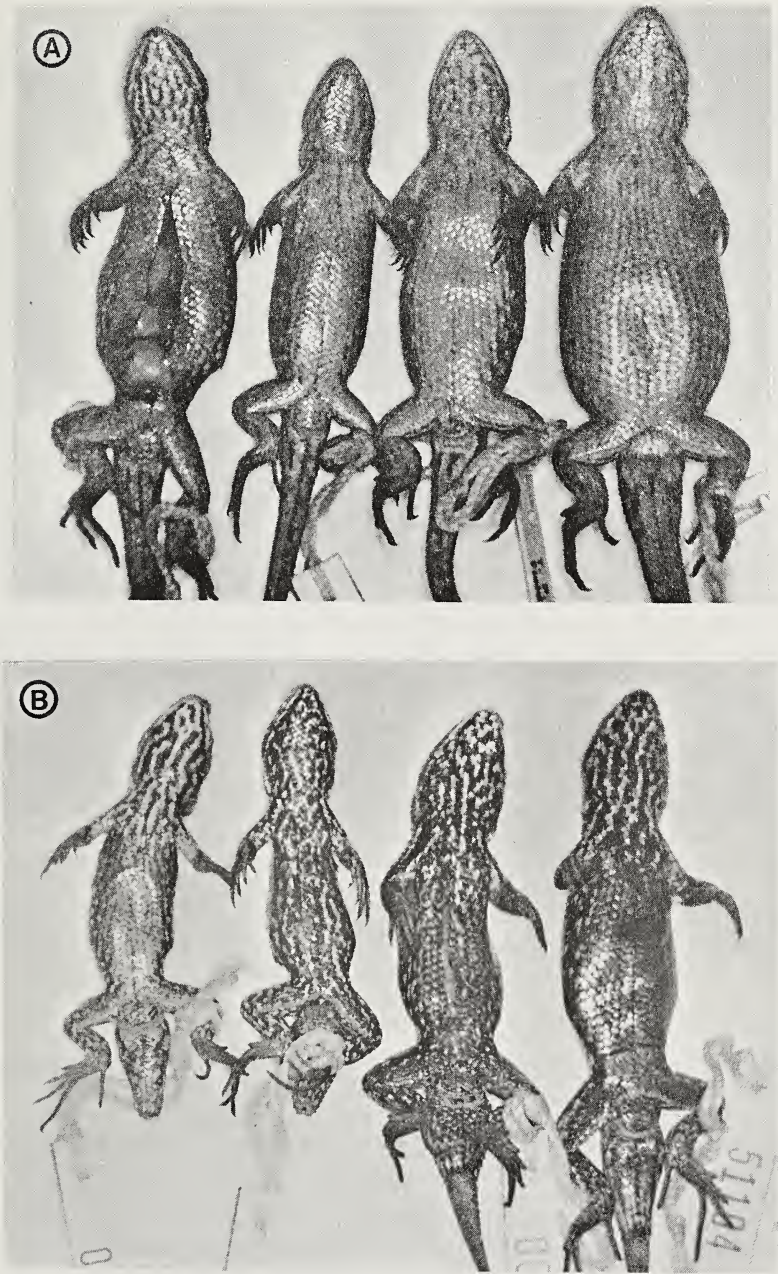


Figure 3. Ventral color pattern of female (A) and male (B) *Sceloporus bicanthalis*.

5. Distribution and Habitat

The distribution of the two parity types is indicated in Figure 4. Temperature and precipitation do not differ at sample sites (Figure 5). The "bicanthalis" parity type ranges from the eastern perimeter of the valley of Mexico east to the Sierra Madre Oriental of the state of Veracruz, from 2900 to 4400 m. It inhabits open pine forests, with average cover densities of 12.8 ± 0.64 m of ground cover per 25 m (51.2% coverage). The "aeneus" type occurs from the western ridge of the valley of Mexico westward into the state of Michoacán as far as the mountains surrounding the city of Uruapan, from 2350 to 3050 m. As in "bicanthalis," it inhabits open pine forests, although the ground cover density is less than in the "bicanthalis" sites (8.95 ± 0.49 m of ground cover per 25 m, 35.8% cover; $t = 2.77$; $df = 30$; $P < .01$). In addition, "aeneus" occurs in disturbed areas such as corn fields and around houses in small villages, whereas "bicanthalis" was never obtained from similar disturbed areas. The two parity types are dichopatric in distribution; that is, the two populations have no area of contact although they do come within 10–15 kilometers of one another. There is one reported disparity in the literature: Smith and Brandon (1976) reported specimens of "*S. a. aeneus*" from the area of Huauchinango, Puebla, in the region inhabited by *S. a. bicanthalis* auct. We have re-examined these specimens and they are definitely "aeneus" as are two series of specimens (IBHUNAM 4447–4449) from Omittepec, Hidalgo, and Piedras Encimadas, Puebla, northwest and southeast of the Brandon and Smith location, respectively. However, additional specimens in the Museum de Zoología, Facultad de Ciencias, UNAM, from the same region surrounding Huauchinango, are "bicanthalis." A thorough field study of this region could clarify this problem quite simply. A similar problem exists in the region of Nevado de Toluca, Mexico, in the territory inhabited by the "aeneus" complex. Recently, it was noted that females from high elevations (3500 m and higher) exhibit viviparity (this study and G. Lara, personal communication). These females are seemingly referable to the nominal subspecies "*S. aeneus subniger*" of Poglayen and Smith (1958). All specimens collected have one canthal and dark ventral surfaces with barred chins. Morphologically, they are indistinguishable from "aeneus" specimens except for ventral coloration. A thorough investigation of the reproductive biology and taxonomy of this population is currently underway.

6. Reproductive cycles.

The reproductive cycles of "aeneus" and "bicanthalis" have recently been reviewed in detail (Guillette, 1981a, b). The "aeneus" type is characterized not only by oviparity, but also by spring (April, May) courtship and mating, and summer (May, June) ovulation. In contrast, the "bicanthalis" type exhibits fall-winter courtship and mating (October, November, December) as well as ovulation (January, February) (Guillette, 1982). Other aspects of reproductive activity are similarly disparate, including the period of peak testicular activity, vitellogenesis, presence of oviductal ova, and development of corpora lutea and follicles (Guillette, 1982). The oviparous "aeneus" type lacks a placenta, of course, whereas the "bicanthalis" type possesses both choriovitelline and chorioallantoic placentae (loc. cit.). The former type may produce two clutches per year, and its eggs are relatively small and numerous at ovulation; the latter type

produces one clutch per year and its eggs are relatively large and less numerous at ovulation (Guillette, 1982).

Discussion

The color morphs observed in the females of the two population types suggest that differential predation may be a determining factor. Female "aeneus" exhibiting the unicolor morph were always obtained in areas of low ground cover density and sandy soil. Major predators of these organisms are birds. Cryptic coloration is useful in protection from predation (Clarke, 1954; Gibbons and Lillywhite, 1981) and in some cases may lead to speciation (Gibbons and Lillywhite, 1981). An example from the "bicanthalis" population also points to differential predation, for the commonly obtained females in the pine needle covered forest floor were of the cinnamon colored morph. In both cases, the only way these animals were observed was by movement. In the normal area of habitation, the brown background females with the series of bars and longitudinal lines were very well camouflaged in the tall bunch grasses whereas the cinnamon and unicolor females were conspicuous. The presence of the different color morphs may be due directly to the influence of differential predation.

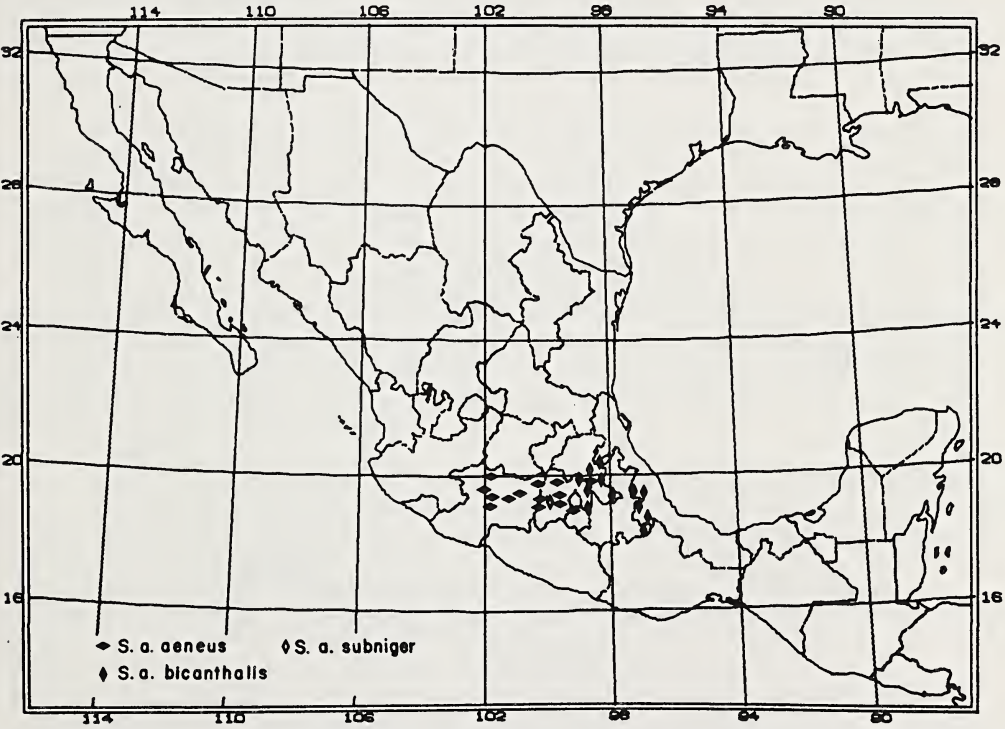


Figure 4. Distribution of the populations of the Mexican lizard complex, *Sceloporus aeneus*.

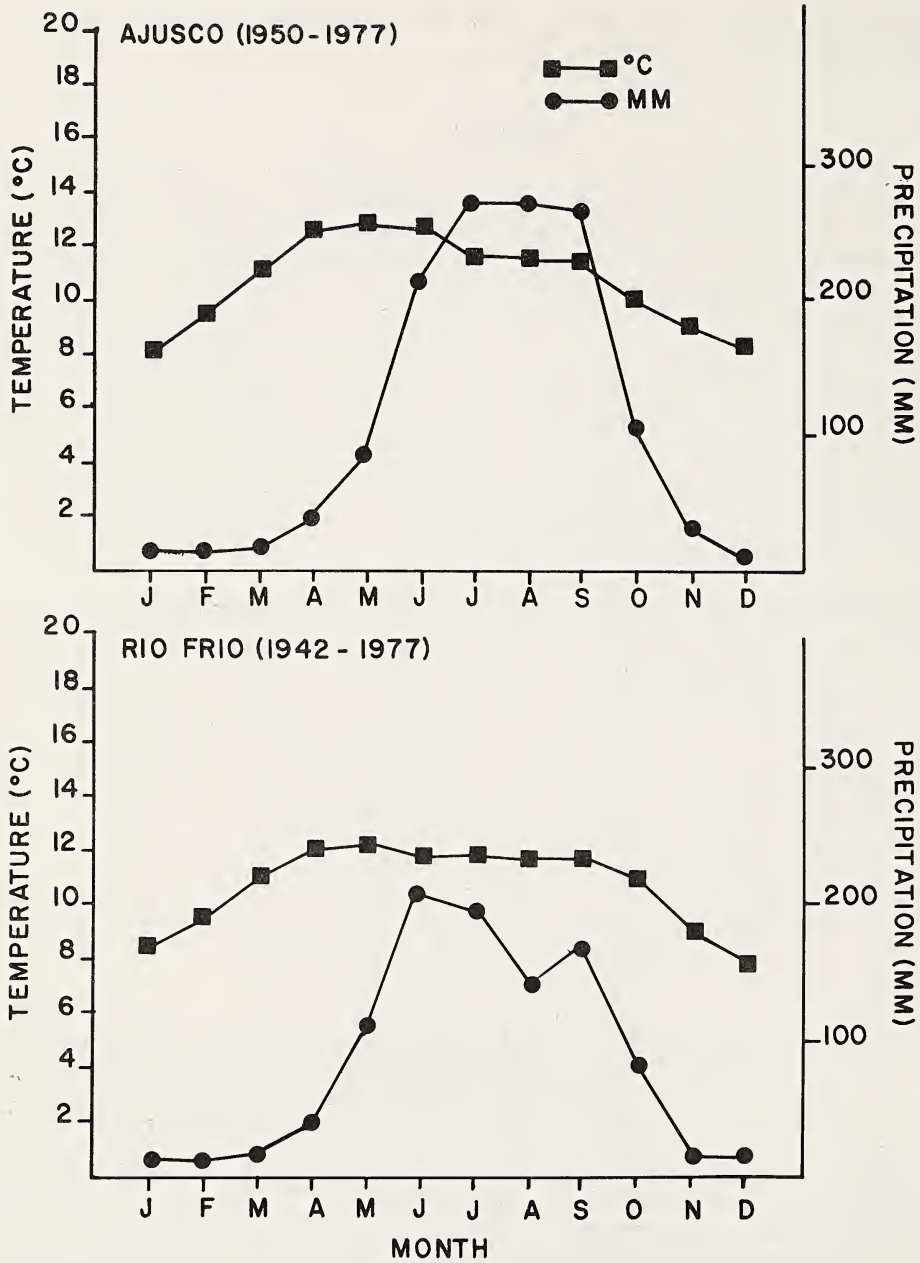


Figure 5. Temperature and precipitation data (means) for two locations in Mexico inhabited by *Sceloporus aeneus* (Ajusco, D. F.) and *Sceloporus bicanthalis* (Río Frío, México).

The history of the study of *Sceloporus aeneus* suggests that the two parity types are at least closely related if not taxonomically identical. The extensive similarities of the two types leads us to agree, for morphological differences are slight indeed. Karyotypic and preliminary electrophoretic data (Guillette, 1981b) provide no support for recognition of a taxonomic level of differentiation.

Yet genetic morphology is not an infallible clue to taxonomic differentiation, primarily because techniques do not yet exist for exhaustive analysis (Mayr, 1970; Wake, 1981). Genetic controls for the differences that do exist, given their populational constancy, must be present, however difficult they are to isolate.

Additionally, the differences that do exist not only exhibit a high degree of correlation (perfect for some), but include seemingly absolute isolating mechanisms. The two population types can be distinguished at 100% level by either reproductive mode or canthal number (with a great correlation), or approximately at a 90% level using throat region pattern and color. The two population groups are, so far as known, dichopatric although only a few kilometers (10-15) separate them in some areas. In other regions they may be parapatric or even sympatric; additional field work will be required to resolve that question. However, Guillette carefully explored geographic approximation zones and found no evidence whatsoever of character approximation suggestive of hybridization or intergradation. Not a single intermediate was found in over 500 museum specimens examined.

Most critical is the obvious isolating influence of the trenchantly different reproductive cycles of the two populations. The difference in parity type alone would seem a likely barrier to interbreeding, but the difference in seasonality leaves nothing to chance. The two populations cannot interbreed in spite of their geographic and habitat proximity.

The evidence now available permits no conclusion other than that the "aeneus" and "bicanthalis" populations represent separate, distinct, cryptic (sibling, sensu Mayr, 1970), biological species, properly designated as *Sceloporus aeneus* and *S. bicanthalis*, respectively, as proposed thirty years ago by Davis and Smith (1953: 102) on the grounds that the former is oviparous, the latter viviparous.

More recently Smith and Hall (1974: 97-99) reasoned erroneously that "*S. a. aeneus*" is not only viviparous but reproduces in alternate years, and on the criterion of parity they distinguished an oviparous *scalaris* complex from a viviparous *aeneus* complex. On that same criterion a viviparous *bicanthalis* complex (containing *bicanthalis*, *goldmani* and presumably *subniger*) can now be recognized, with *aeneus* now falling with *scalaris* (four subspecies) in what is least confusingly designated the *scalaris* complex, all members being oviparous. Whether this arrangement accurately reflects phylogeny is uncertain; viviparity may have arisen quite independently in each of the three taxa in which it occurs, and, in view of the primitively diagonal lateral scale rows of one of them (*goldmani*), parallel in all other members of the *scalaris* group, it very likely has at least in that species.

Additional data are necessary before a definitive phylogeny of the members of the *scalaris* group can be admitted.

Cole (1978) eliminated *Sceloporus jalapae* from the *scalaris* group, leaving that group now with certainly at least four species, one with four subspecies. The discovery here first reported of viviparity in *subniger* requires its tentative elevation to specific rank from its former allocation as a subspecies of *S. aeneus*, in the interest of consistency of treatment of that apparent natural pair with the documented treatment of another oviparous-viviparous pair, namely *S. aeneus* and *S. bicanthalis*. The validity of that tentative extrapolation, however, is subject to verification or rejection by researches now in progress.

The taxa of the *Sceloporus scalaris* group, as understood at present, as well as the *Sceloporus bicanthalis* group, can thus be distinguished by the following key.

Key to Species and Subspecies of the
scalaris Group of the Genus *Sceloporus*

- 1. Lateral scales in distinctly oblique rows; dorsals 50-55; two canthals; gular region irregularly barred in both sexes; venter white, with very little melanin; in males a blue lateral abdominal patch; viviparous...
.....*goldmani*
- Lateral scales in parallel rows; dorsals 36-50; canthals one or two; color as described or not; either viviparous or oviparous.....2
- 2. One canthal.....4
- Two canthals, the anterior occasionally forced above canthal ridge by contact of the posterior and subnasal.....3
- 3. Males with much black in ventral coloration; tibia/head proportion usually less than 0.90; max. s-v length 56 mm; viviparous.....
.....*bicanthalis*
- Males without much black in ventral coloration, limited at most to bars on throat and sides of abdomen; tibia/head proportion usually more than 0.90; max. s-v length 78 mm; oviparous.....*scalaris scalaris*
- 4. Males with much black in ventral coloration.....5
- Males with black, if present, confined to bars on throat and sides of abdomen; oviparous.....6
- 5. Throat barred, viviparous.....*subniger*
- Throat not barred, oviparous.....*aeneus*

6. Tibia/head proportion usually more than 0.90; scales of 2nd pair of postmentals usually in contact; max. s-v length 65 mm.....*scalaris unicanthalis*
- Tibia/head proportion usually less than 0.90; scales of 2nd pair of postmentals separated; max. s-v length 61 mm.....7
7. Gular region barred; dorsals 44 or more (100%); max. s-v length 51 mm....*scalaris samcolemanni*
- Gular region not barred; dorsals 43 or fewer (84%); max. s-v length 61 mm.....*scalaris slevini*

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REPRODUCTION IN THE MOLE KINGSNAKE,
Lampropeltis calligaster rhombomaculata

The mole kingsnake, *Lampropeltis calligaster rhombomaculata*, ranges from the vicinity of Baltimore, Maryland south to the Florida panhandle and westward to central Tennessee and southern Mississippi (Conant, 1975). It is a fossorial species most often seen at twilight. Because of its secretive habits, little is known of its natural history, especially its breeding habits. The purpose of this paper is to present new data on eggs and hatchlings of this snake, and to compare reproductive data between the subspecies *L. c. calligaster* and *L. c. rhombomaculata*.

On 2 June 1984, an obviously gravid female mole kingsnake was captured by Lovich at Woodbridge, Prince William County, Virginia. Its measurements were as follows: total body length, 851 mm, snout-vent length, 753 mm, tail length, 98 mm (11.5% of total body length). The snake was brought to George Mason University (GMU) where it was housed in a Neodesha, 24 inch reptile cage. She shed on 24 June, and, as ecdysis has often preceded oviposition by 7-10 days in other captive *Lampropeltis* we have kept, a nesting box with damp sawdust was provided the next day.

Sixteen white, smooth-shelled eggs were laid on 5 July; fifteen regularly-shaped, elongated eggs and one smaller, almost round egg. This is a record clutch for *L. c. rhombomaculata*. The eggs were measured with dial calipers accurate to 0.1 mm (unfortunately no weights were taken), and placed in moist sawdust in a gallon jar and incubated at room temperature (approximately 23°C). A group of eight elongated eggs and the smaller rounded egg comprised a large adherent cluster, while two other elongated eggs were also stuck together in a separate cluster. Adherence in *Lampropeltis* eggs is well known (Blanchard, 1921).

The female shed again on 29 July, but refused all food and was eventually preserved (GMU 2454).

Hatching began on 19 September and the last hatchling emerged on the 21st, an incubation period of 76-78 days. Nine young emerged. Of the other seven eggs, five contained near term dead embryos (GMU 2538), one was destroyed early in incubation by mold, and the smaller rounded egg was infertile. Egg and hatchling parameters are presented in Tables 1-2, and Figure 1 shows a plot of weight versus total body length in the nine hatchling *L. c. rhombomaculata*. The young snakes immediately showed belligerent dispositions, shaking their tails and striking when approached. Ecdysis began on 30 September with the last hatchling shedding its skin 9 October. Five hatchlings were preserved (GMU 2539-2543), and the other four were released at the Mason Neck National Wildlife Refuge Fairfax County, Virginia on 12 October.

Tables 1-2 present comparative data on nesting dates, eggs, incubation periods, hatching success, and hatchling parameters for *L. c. rhombomaculata* and the western subspecies *L. c. calligaster*. Nesting occurs in both subspecies during June and July, and there is no significant difference in mean clutch size between the two races (chi-square test, $p > 0.05$). However, it is apparent that *L. c. calligaster*, the slightly longer subspecies (Conant, 1975), lays larger, heavier eggs. Hatching occurs in August and September in both subspecies. The relatively long incubation period we report, comparable only to that reported for a Missouri *L. c. calligaster* by Anderson (1965), was probably due to a lower incubation temperature. Table 2 shows that the hatchlings of *L. c. calligaster* are also significantly larger and more heavy (chi-square test, $p > 0.05$) than those of *L. c. rhombomaculata*. In Figure 2, clutch size is plotted against female total body length for the Virginia clutch and those literature clutches with corresponding data. Generally, clutch size increases with greater female body length.

Tryon and Carl (1980) determined, by hemipenial eversion, the sex ratio for their 17 hatchling *L. c. rhombomaculata* to be 11 males and 6 females. Their males had tail lengths of 10.4-15.5% ($\bar{X} = 13.2\%$) of total body length, while those of their females were 11.0-13.0% ($\bar{X} = 12.1\%$). Sexes of the nine Virginia hatchlings were determined by tail length to be four males and five females. The males had tail lengths of 12.5-14.5% ($\bar{X} = 13.8\%$) and the females, 11.0-12.0% ($\bar{X} = 11.4\%$).

TABLE 1. Egg data for the snake, *Lampropeltis calligaster*
(measurements in mm; weights in g).

	Clutch Size	Mean Length	Mean Width	Mean Weight	Incubation Period (Days)	Hatching Rate (%)	Source
<i>L. o. rhombomaculata:</i>							
Virginia							
5 July	16	27.8 (25.3-33.3)	21.1 (17.4-23.2)	---	76-78	9(56)	
Georgia							
2 June	5	39.6 (37-43)	16 (14-17)	6.4	49-54	4(80)	Tryon & Carl, 1980
7 June	13	29.7 (27-34)	18.3 (17-19)	5.7	49-54	13(100)	Tryon & Carl, 1980
Maryland							
11 June	15	---	---	---	---	---	Howden, 1946
<i>L. o. calligaster:</i>							
Illinois							
August (found)	11	---	---	---	---	---	Blanchard, 1921
17 August (found)	9	44-49	24-28	---	---	---	Cagle, 1942
19 June	11	37.9 (34-43)	21.1 (19-22)	10.7 (10-11.4)	45-46	9(90)**	Shoop, 1957
27 June	8	40.0 (38-46)	18.0 (17-19)	8.9 (8.2-9.6)	49-50	7(88)	Shoop, 1957
5 July	9	---	---	---	---	---	Smith, 1961
6 July	18	---	---	---	52	13(72)	Miller, 1962
Indiana							
22 July	11	---	---	---	54***	---	Minton, 1972
Kansas							
15 July	9	44.1 (41-48.5)	21.0 (19-22)	11.6 (10.9-12.4)	---	---	Clarke, 1954
25 June (found)	13	---	---	---	54-55	13(100)	Fitch, 1978
19 June	7	---	---	---	67-68	---	Fitch, 1978
	10	---	---	---	62-63	---	Fitch, 1978
Missouri							
13 July	6	50	20	---	---	---	Anderson, 1965
23 June	12	47	21	---	73-75	13(100)	Anderson, 1965
August (found)	13	---	---	---	---	---	Anderson, 1965
22 June	17	---	---	---	---	---	Dietrich, 1960
Nebraska							
9 June	13	---	---	---	53	---	Iverson, 1975
Oklahoma							
1 July	14	39.3	23.7	---	---	---	Carpenter, 1958
20 July	14	24.3	16.5	---	---	---	Carpenter, 1958
Texas							
17 June (dissected)	8	---	---	---	---	---	Guldry, 1953

** = One egg opened by Shoop.

*** = Embryos killed just before hatching.

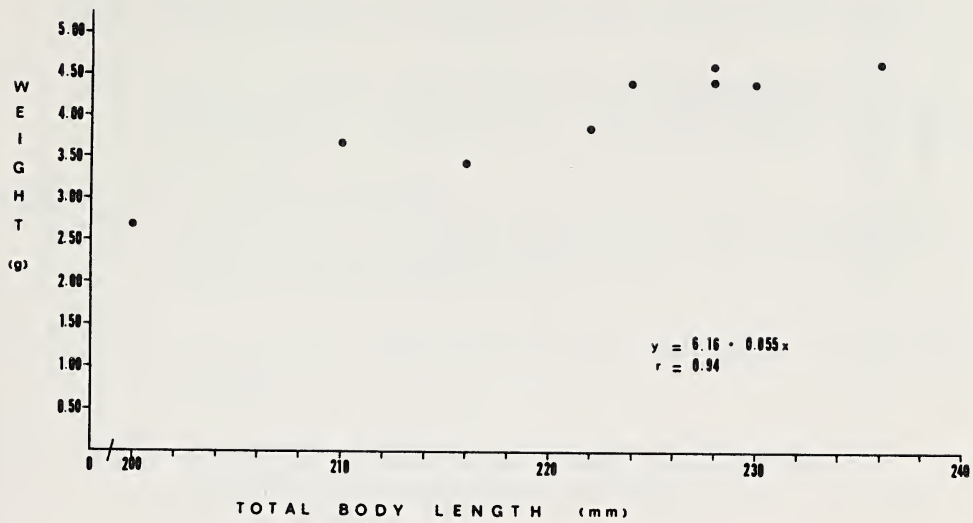


TABLE 2. Hatchling data for the snake, *Lampropeltis calligaster*
(measurements in mm, weights in g).

	N.	Mean			Weight	Source
		Total Length	Snout-Vent Length	Tail Length		
<i>L. c. rhombomaculata:</i>						
Virginia	9	221.6 (200-236)	193.4 (176-210)	28.1 (24-33)	4.0 (2.7-4.7)	
Georgia	4	220.7 (193-236)	---	---	5.5 (5.1-6.4)	Tryon & Carl, 1980
	13	219.5 (210-230)	---	---	5.8 (4.9-6.5)	Tryon & Carl, 1980
Maryland	9	225	---	---	---	Grogan & Prince, 1971
<i>L. c. calligaster:</i>						
Illinois	9	260.5 (249-271)	---	33.4 (28-37)	9.1 (7.7-10.1)	Shoop, 1957
	7	265.4 (250-277)	---	33.5 (32-39)	7.5 (6.9-8.0)	Shoop, 1957
Indiana	3	244-255	---	---	---	Minton, 1972
Kansas	26	---	272 (234-308)	---	7.96 (6.9-12.2)	Fitch, 1978
Nebraska	13	297 (290-305)	---	---	---	Iverson, 1975

Figure 1. The relationship of weight to total body length in hatchling *Lampropeltis calligaster rhombomaculata* (N = 9).

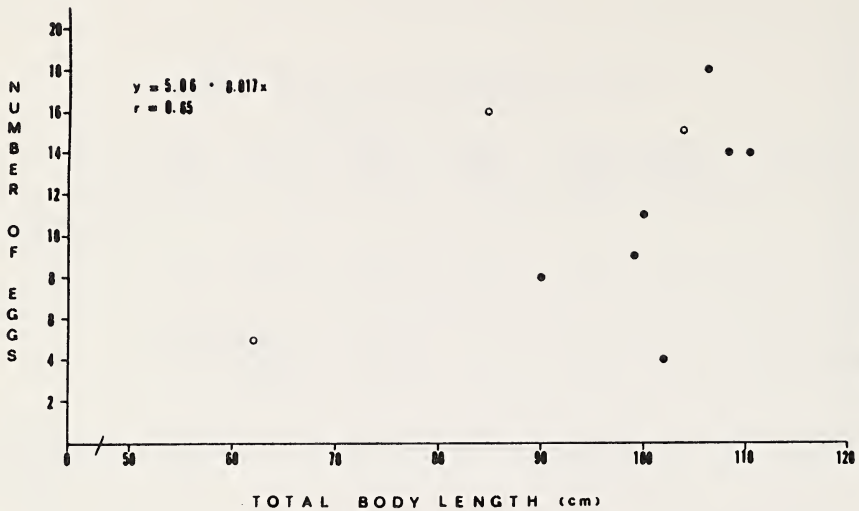


Figure 2. The relationship of clutch size to female total body length in the snake, *Lampropeltis calligaster* (N = 10). Solid circles = *L. e. calligaster*; hollow circles = *L. e. rhombomaculata*.

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BEHAVIOR OF PNEUMONECTOMIZED *CRYPTOBRANCHUS ALLEGANIENSIS*

Three acute experiments have helped elucidate respiratory functions in the hellbender, *Cryptobranchus alleganiensis*. Robin (see Hughes, 1967) demonstrated that submerged hellbenders survive (duration not stated) without lungs or patent body orifices. This is possible because underwater gas exchange is primarily transcutaneous (Guimond and Hutchison, 1973, 1976; Boutilier and Toews, 1981). When body rocking is prevented, thus skin fold ventilation decreased, however, maintenance of blood oxygen tension fails (Harlan and Wilkinson, 1981). The lungs may therefore be less respiratory than hydrostatic in this form but long-term studies of lung-deprived animals are lacking. We determined the consequences of pneumonectomy on long-term survival and behavior of unrestrained salamanders under conditions conducive to respiratory activity (warm tank) with those in a "minimum activity" environment (cool tank) where water currents could be interrupted to test the effect on rocking activity.

Twelve hellbenders, 27-49 cm total length (\bar{X} = 38 cm) and 69-430 g (\bar{X} = 238 g) were caught in the Allegheny River 3 km south of Tionesta, Pennsylvania, during August. Water temperature under rocks harboring salamanders ranged from 18-25°C. Hellbenders were held at 5°C for one week and pneumonectomized under .05% tricaine (MS222) anesthesia. The lungs were lifted through a midventral incision behind the xiphisternum and returned (6 sham controls) or ligated and removed (6 experimentals). Monofilament loops through the caudal fin and natural scars served as individual markers. Three operated and 3 control animals matched by length were placed in each of two 40 l aquaria. Water temperature in the warm tank varied with ambient temperatures and ranged from 20-24°C (\bar{X} = 21.7°C). This tank was aerated by several airstones leaking compressed air. Water temperature in the cool tank was held at 15-17°C (\bar{X} = 16.1°C) by an external refrigeration unit. Water was circulated through the refrigerator to return to one corner near the bottom. Circulation was stopped to determine whether rocking behavior would ensue. Water temperature rose 1-1.5°C during these tests. Salamanders in the warm tank were fed crayfish every 2 weeks but those in the cool tank were not fed. Activities were recorded for a few minutes at all hours (39 observations at 0100-0600; 78 at 0600-1200; 127 at 1200-1800; 123 at 1800-2400). Trips to the surface, air gulping, rocking (scored as a sharp lateral body tilt and return) movements, crawling, swimming, and floating incidences were tabulated. Crawling and swimming were unaltered by pneumonectomy and are not discussed.

The clearest difference between control and experimental animals in both tanks concerned body orientation relative to the water surface when floating. Hellbenders would swim toward the surface and float just beneath it for several seconds (8-40, \bar{X} = 31) often without gulping. Intact salamanders floated with the body roughly paralleling the surface but pneumonectomized animals floated at an angle to the surface (Figure 1). No movements suggestive of discomfort were noticed and there were no consistent differences in duration of floating between control and experimental animals.

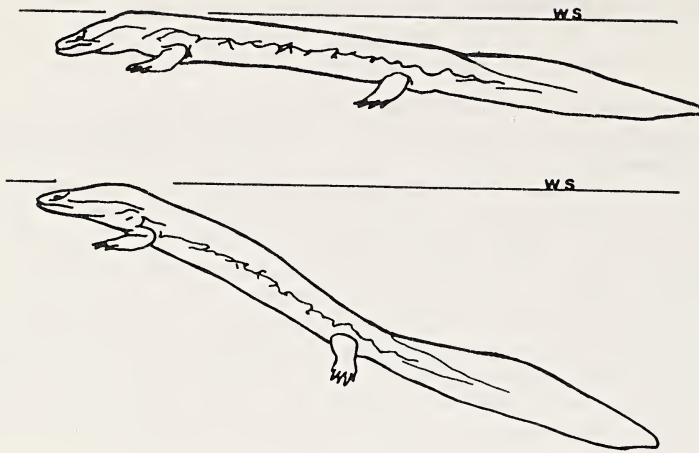


Figure 1. Intact hellbenders typically floated just under and roughly parallel to water surface (WS) as shown at top. Pneumonectomized animals, however, floated at an angle to water surface (bottom) with trunk and tail pointing toward substrate. Air gulping did not necessarily accompany floating in either control or lung-deprived animals.

In the warm tank, one pneumonectomized animal surfaced on numerous occasions to gulp air (\bar{X} = 11 trips/10 min), which often leaked from its mouth during resubmergence. The other gulper was a control whose overall surfacing rate averaged 3 trips/10 min interval of observation. Neither the other experimental nor control animals were observed to gulp air. A non-gulping control consistently positioned itself close to an airstone and rocked the least (\bar{X} = 5 times/min). This was less than the mean rocking frequency (16 rocks/min) of the control gulper. The pneumonectomized gulper also rocked fewer times (13/min) than did the pneumonectomized non-gulpers (\bar{X} = 20 times/min). The non-gulping control died after 3 months but the 3 pneumonectomized and 2 control salamanders were vigorous when released 12 months after the experiment began.

Salamanders in the cool tank behaved quite differently. They generally remained relatively quiet and piled atop each other directly beside the water inlet. One occasionally rocked feebly but never in a sustained bout. There was a preference for the bottom of the pile and an animal at the top or middle would occasionally slip out, crawl or swim about to return to burrow into the bottom of the pile. On 12 occasions water circulation was turned off for 2 hours. Within 20 min on each occasion all the animals began to rock. This generally resulted in the pile breaking up, but some times one animal would attempt to rock on top of or beneath the others. We failed to

distinguish any clear differences in vigor or frequency of these rocking motions regarding control versus experimental hellbenders. Rather, each seemed to have some idiosyncratic rocking pattern. This was highly variable, the most common rocking frequencies being between 15-50 min. A few instances of continuous rocking were seen while circulation was interrupted, but as often by a control as by a pneumonectomized animal. Similarly, small salamanders rocked as often as did larger ones. Thus neither lack of lungs nor surface:volume ratio of the animals significantly influenced rocking activity. Two controls and 2 experimental animals died after 6-7 months. The two survivors (1 control, 1 experimental) were killed in poor condition 10 months after the experiment began.

Pulmonary gas exchange in hellbenders may be an auxiliary respiratory mechanism serving under hypoxic conditions, as in goldfish which gulp air (Burggren, 1982). The differences in sub-surface floating postures of experimental and control salamanders suggest, however, that the lungs may function more as hydrostatic organs mediating buoyancy. Under hypoxic conditions this could enable the animal to remain close to oxygen-rich, near-surface environments, thus facilitating transcutaneous respiration or air gulping. Our observations demonstrate that lungs are not essential for long-term survival of hellbenders under the conditions described. These results extend the significance of Robin's (see Hughes, 1967) original observation and suggest that similar surgical preparations may serve in more extensive analysis of respiratory gas transport partitioning in this form. Rocking behavior is not exaggerated in pneumonectomized hellbenders but is begun or intensified when currents cease. Rocking by control individuals under the same conditions suggests that pulmonary gas exchanges are of relatively minor physiologic importance, as previously shown by acute gas analysis in forcibly submerged (Guimond and Hutchison, 1973) and anesthetized (Harlan and Wilkinson, 1981) hellbenders. This reemphasizes the importance of rocking as a ventilatory assist in *Cryptobranchus* (Beffa, 1976) and suggests yet another means of optimizing gas exchange by an aquatic organism in hypoxic environments (see Liem, 1981). Impairment of hydrostatic adjustments in this form might limit survival under natural conditions though hellbenders can survive for 2 weeks when submerged or exposed in air (Guimond and Hutchison, 1976). It would be interesting to monitor the success of free-ranging, pneumonectomized hellbenders.

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FROG MOUNTAIN: PRELIMINARY COMMENTS ON THE GENUS
Eleutherodactylus ON THE ISLAND OF GUADELOUPE, WEST INDIES

Frog Mountain stands stark and jagged above the narrow streets and bright green banana fields in the village of St. Claude. Janet and I had driven up to St. Claude after midnight and then on toward the summit of the mountain itself. In those days the high mountain road was still being built, and at its end we suddenly found ourselves trapped between moss-covered ledges and empty space. The pungent odor of sulphur was heavy in the air, fog lay white and thick upon the mountain, and bitter winds knifed across the slopes, bringing with them solid walls of cold, wet rain. It would have been, in fact, a totally miserable place except for the singing of hundreds upon hundreds of frogs. Janet, soaked and shivering, laughed and said "They should have called this place 'Frog Mountain'".

They didn't, of course. They called it, instead, "La Soufrière". The volcanic peak of Soufrière stands 4,800 feet above the sea, and the mountain itself is the dominant geologic feature of Basse Terre, westernmost of the two islands which together form the single "island" of Guadeloupe (Figures 1 and 3).



Figure 1. Mount Soufrière, Guadeloupe, near the summit. Beyond the tree line on this mountain strange things begin to happen.

For a very long time, only one member of the genus *Eleutherodactylus*, *Eleutherodactylus martinicensis*, was known to occur on Guadeloupe. Then John Lynch discovered a second species, *Eleutherodactylus barlagnei*, in the highlands of Basse Terre (Lynch, 1965); and two years later Al Schwartz discovered a third, *Eleutherodactylus pinchoni*, in the same general region (Schwartz, 1967). Janet and I had gone to Guadeloupe to compare these three species to frogs which we were then studying on several islands south of Guadeloupe. It would have been a simple, one-time trip; but strange things began to happen, particularly on Frog Mountain, and we found ourselves returning again and again in an effort to unravel the mysteries of the island's *Eleutherodactylus* and their significance in the overall biogeography of the Lesser Antilles.

The mysteries, by and large, remain exactly as they were, mysterious and totally unresolved. The purpose of this short paper, then, is to make the data which my colleagues and I have so far collected available to other students of Caribbean biogeography. It should be noted, however, that most of the data have not yet been adequately analyzed or interpreted.

Soon after our initial trip, Janet and I returned to Guadeloupe with Dr. George Drewry. Our first discovery of any real significance was the occurrence on Guadeloupe (probably through recent introduction) of *Eleutherodactylus johnstonei*, a species not recorded from the island by Schwartz in his excellent review of *Eleutherodactylus* in the Lesser Antilles (Schwartz, 1967).

As a result, also, of that trip, and of the voice recordings which we made, we were able to expand on Schwartz's review of the *auriculatus* group of *Eleutherodactylus*, a study which was based primarily on differences and similarities in patterns of vocalization of the various species within the group (Schwartz, 1969). Briefly stated, where Schwartz found unique differences among the voices of the four Guadeloupean species, we found the voices of three of them to be strikingly similar.

Among members of the *auriculatus* group of the genus *Eleutherodactylus* (to which all of the Guadeloupean species belong) there are at least two distinctive call types. Some species, such as the Puerto Rican coqui, *Eleutherodactylus portoricensis*, produce a call consisting of an initial low-frequency note followed by one or more notes at a higher frequency; while others, such as *Eleutherodactylus urichi* of Trinidad and Tobago and *Eleutherodactylus hedricki* of Puerto Rico, produce calls of one or more notes, but always of the same frequency (Drewry, 1970; Wells, 1981). On Guadeloupe we found that *Eleutherodactylus johnstonei*, *Eleutherodactylus martinicensis*, and *Eleutherodactylus barlagnei* produce what are basically two-note (two frequency) calls, while *Eleutherodactylus pinchoni*, at least in the lowlands, produces a distinct, high frequency, single-note call.

Above the tree line on "Frog Mountain" the call of *Eleutherodactylus barlagnei* is slightly, but consistently different from the call of *barlagnei* lower down on the mountain; the call of *Eleutherodactylus martinicensis*, rapid and with the notes slurred together at sea level, is noticeably slower

and of lower frequency above the tree line (sounding very much like the call of *Eleutherodactylus coqui* in Puerto Rico); and "*Eleutherodactylus pinchoni*", a single-note caller in the lowlands, produces a highly distinctive two-note call sounding very much like the call of *Eleutherodactylus johnstonei* as previously described (Watkins, et al., 1970; Lemon, 1971; Hardy and Harris, 1979).

The upland population of *Eleutherodactylus pinchoni* may, in fact, be a distinct and as yet unnamed species. These frogs, in addition to their distinctive voices, are consistently larger than their lowland counterparts, and have, at least in some specimens, unique ventral pigment patterns and highly characteristic broad, pale dorso-lateral stripes. My colleague and recent field companion, Mr. Blair Hedges, of the Department of Zoology, University of Maryland, has electrophoretically compared the proteins of the two "*pinchoni*" populations, and has noted differences in the frequency of occurrence of certain protein bands in his resulting electropherograms. His work suggests that the upland frog may, indeed, be distinct, but a problem yet remains: Some of the frogs above the tree line produce the single-note call of typical lowland *pinchoni*, and there is the chance that our recent upland collections may have contained both forms (or species). We need to return to Guadeloupe, carefully document the call types of individual frogs, and then make new protein comparisons.

George Drewry, who had previously done a considerable amount of work with the chromosomes of *Eleutherodactylus* in both Puerto Rico and Jamaica, made chromosome counts on all four of the named Guadeloupean species, as well as on all insular species occurring south of Guadeloupe. The four Guadeloupean species all have 28 chromosomes (Figure 2). Northward, those members of the *auriculatus* group for which chromosome data are available have 26 or fewer chromosomes (Bogart, 1981); while on islands south of Guadeloupe all species which are assumed to be members of this group have more than 30 chromosomes (Figure 3). Blair Hedges (personal communication), on the basis of work done by Dr. James Bogart with frogs from our recent field trip, states that, like the other Guadeloupean members of the genus, upland "*Eleutherodactylus pinchoni*" (or *Eleutherodactylus* sp.) also has 28 chromosomes.

Assuming that the widely introduced *Eleutherodactylus johnstonei* is of eastern Caribbean origin (Hardy and Harris, 1979), the Guadeloupean species appear to represent a discrete eastern Caribbean sub-unit of the *auriculatus* species group. There appears, also, to be a northward decrease in chromosome numbers among members of the *auriculatus* group throughout the entire Caribbean.

On the basis of chromosome counts, and to a lesser extent, similarities in call structure, it would appear that the four (or five) species of *Eleutherodactylus* on Guadeloupe are more closely related to one another than has previously been supposed. On the other hand, two of the species exhibit unique morphological or embryological features; and our work on biochemistry, involving so far only leg muscle proteins, suggests significant similarities between only two of them.



Figure 2. Typical 28-chromosome smear, upland *Eleutherodactylus pinchoni* (or *Eleutherodactylus* sp.).

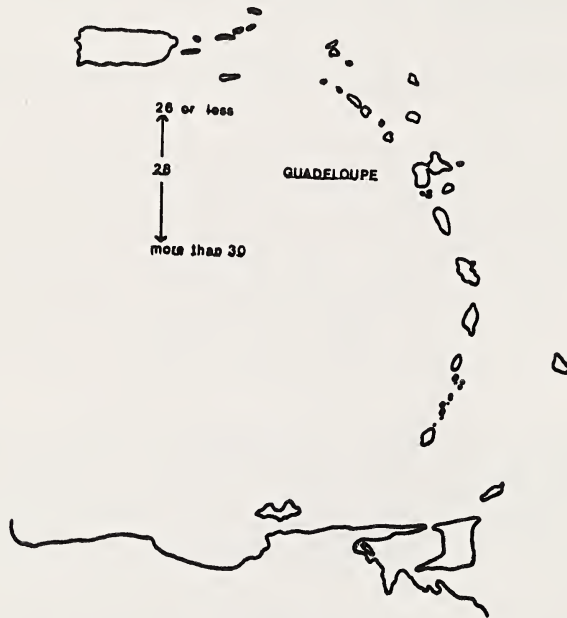


Figure 3. The southeastern Caribbean, with Guadeloupe indicated. The various species of *Eleutherodactylus* in Guadeloupe, all of which are members of the *auriculatus* group, have 28 chromosomes. Based on current knowledge, chromosome counts within this group are reduced northward to 26 or less, and increase southward to more than 30.

Eleutherodactylus barlagnei differs from all other Guadeloupean *Eleutherodactylus* in having the toes slightly webbed rather than entirely un-webbed (Schwartz, 1967).

Among those members of the *auriculatus* group for which the egg tooth is known (including *E. johnstonei*, *E. barlagnei*, *E. pinchoni*, and *E. martinicensis* from Guadeloupe) only *Eleutherodactylus martinicensis* and *Eleutherodactylus urichi* (which may not be a member of the *auriculatus* group) have a single-pointed rather than bifurcate egg tooth, Hardy, 1984). Both *Eleutherodactylus martinicensis* and *Eleutherodactylus urichi* occur at the extreme southern limits of the range of the *auriculatus* group. The single-pointed egg tooth of *Eleutherodactylus martinicensis* may, therefore, prove to be of considerable evolutionary significance.

Dr. Raymond Morgan and I have made comparisons of the leg muscle proteins of *E. martinicensis*, *E. pinchoni*, *E. barlagnei*, and *E. johnstonei* (Figure 4). The muscle sample used for electrophoresis was taken from the muscle complex associated with the Tibia. The muscles were macerated in distilled water, and the supernatant used for polyacrylamide electrophoresis. Protein separation was done on 7% acrylamide gels using a Beckman Duostat and a Canalco model 66 bath. Runs were made at temperatures of 18 to 25°C and at a constant current of 4.2 ma/column. The buffer was a pH 8.3 0.005 M tris-0.039 M glycine system, and a bromophenol-blue tracking dye was used for staining.

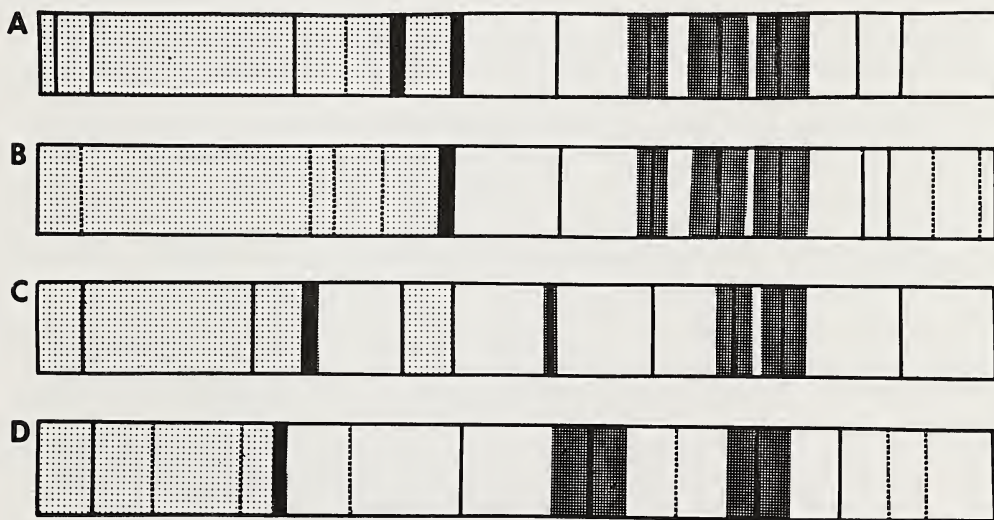


Figure 4. Electropherograms of leg muscle proteins of the named species of *Eleutherodactylus* occurring in Guadeloupe. A. *E. pinchoni*; B. *E. martinicensis*; C. *E. barlagnei*; and D. *E. johnstonei*.

On the basis of simple visual scanning, the leg muscle electropherograms suggests a remarkable similarity in this character between *Eleutherodactylus martinicensis* and *Eleutherodactylus pinchoni*. *Eleutherodactylus barlagnei* is closely similar to *E. pinchoni* and *E. martinicensis*, but conspicuously less like either of them than they are to each other. *Eleutherodactylus johnstonei* is noticeably distinct, showing essentially no similarities to the other three species.

This, then, is the situation as it now stands. Four or possibly five species of *Eleutherodactylus* occur on Guadeloupe, all of which share a common chromosome number (28). Four of these species (or populations) utilize two different frequencies in their calls, while one produces a distinctive, single-note, monotonal call. One is unique in having the toes slightly webbed, while another is unique in having a single-pointed egg tooth. Muscle protein electropherograms show both striking similarities and significant differences. It is obvious, from all of this, that the Guadeloupean *Eleutherodactylus* will demand considerably more study before their significance in the overall biogeography of the southeastern Caribbean can be meaningfully interpreted.

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NEW RECORDS FOR *Chelydra serpentina*
rossignoni IN BELIZE

While *Chelydra serpentina rossignoni* was not recorded as a member of the Belize herpetofauna by Henderson and Hoevers (1975) its presence here was indicated by Pritchard (1979) and is generally known to herpetologists who have worked in the country recently. In order to clarify the distribution pattern of this animal in Belize we provide our accumulated records of its occurrence here with notes concerning its habitat.

- 12 February 1975. Rio Grande River at Big Falls Village, Toledo Dist. adult, approx. 38 cm. carapace length collected under bridge on southern highway. Specimen released (F.D.)
- 2 January 1978. Blue Creek near Blue Creek Village, Toledo Dist. juvenile, found in small, shallow pool approx. .4 Km. e. of village (F.D.)
- 15 January 1978. Aquacate Village, Toledo Dist. Maya family observed slaughtering large specimen purchased from another Maya in San Antonio, Toledo Dist. (F.D.)
- 15 March 1980. Blue Creek Village, Toledo Dist. large specimen captured by students approx. 3.2 Km e. of village (reported to, but not seen by F.D.)
- May 1982. Specimen crossing road between Aquacate and Blue Creek Village, Toledo, Dist. (F.D.)
- January 1983. Monkey Falls on Moho River, Toledo Dist. carapace hanging on wall of Indian hut. (F.D.)
- 6 January 1983. Blue Creek at Blue Creek Village, Toledo Dist. very large adult, approx. 46-50 cm. carapace length, est. wt. approx. 23 Kg. captured by Sylvano Cho of Wheaton College tour group in deep pool (approx. 2.4 M) with stumps and debris (F.D.)
- 29 June 1983. Carapace, bridge, and plastron in museum collection of Saint John's College, Belize City. 40 cm. carapace length. tag reads: "From Dry Columbia Creek at Forest Station, bought 10 July 1971 by Dora Weyer -- probably collected in April" photo available (D.M.)
- 1 March 1984. 1 Km S.E. of Big Falls Village in Rio Grande River Toledo Dist., adult, 35 cm. carapace length. encountered at 1.5 M depth in clear, running water. Specimen released (D.M.)

- 2 March 1984. Golden Stream near Hellgate, Toledo Dist., adult, under Southern Highway Bridge in shallow water. 32 cm. carapace length. Specimen released (D.M.)
- 13 March 1984. Juvenile 5.1 cm. carapace length, crossing road at junction of San Antonio Road and southern highway. Specimen is currently alive in captivity at the Zoological Research Institute, 210 Washington Street, Sherborn, Mass. 01770. (F.D.)
- 20 March 1984. Adjacent to Rio Grande River at Wilson's Landing (near Punta Gorda), Toledo Dist. juvenile 12 cm. carapace length trapped in shallow pond near the riverbank, and adult, 30 cm. carapace length crossing road. Both specimens released. (D.M.)
- 21 March 1984. Moho River, Toledo Dist. ("near mouth") small juvenile 8.2 cm. carapace length. Purchased from fisherman in Punta Gorda. preserved in private collection of Don Moll (DLM 1532).

Despite several years experience in conducting natural history tours in Belize by one of us (F.D.) and rather extensive search and trapping for aquatic turtles throughout Belize during 1983 and 1984 by one of us (D.M.) all of our records of *C. s. rossignoni* are from a rather limited area in Toledo Dist., southern Belize (Figure 1). Based upon the collection data from these specimens optimal habitat seems to be provided by a variety of lotic situations ranging from relatively shallow, high gradient streams to larger rivers. Several individuals were encountered on land near both flowing and standing water, however, and one juvenile was collected in a stagnant pond adjacent to a river.

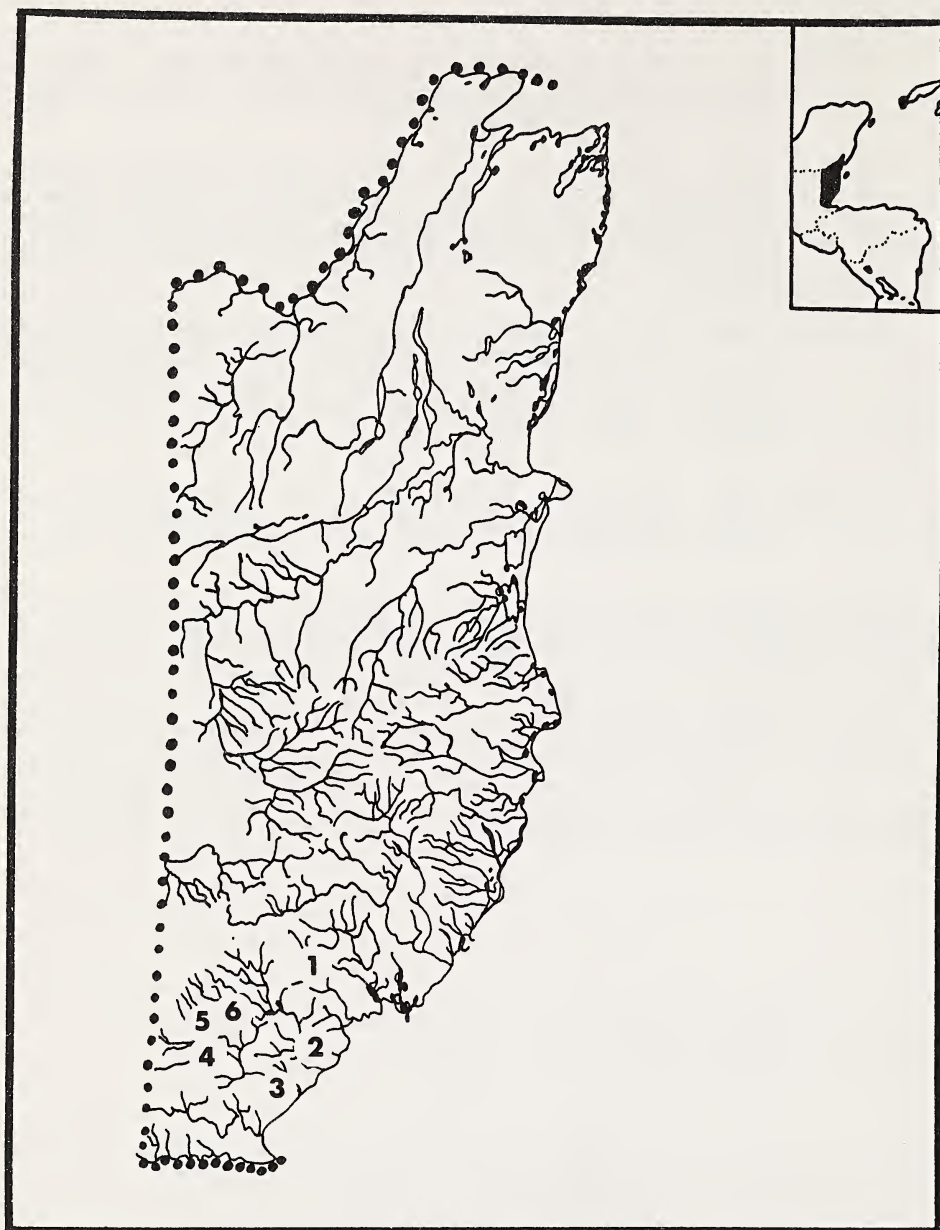


Figure 1. Locations in Belize from which specimens were collected or from which individuals observed on land, in captivity, or in museum collections had probably come. 1. Golden Stream; 2. Rio Grande River and adjacent pond; 3. Moho River; 4. Aquacate Creek; 5. Blue Creek; 6. Dry Columbia Creek.

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A NEW SUBSPECIES OF THE GENUS *Tantillita*
FROM SOUTHERN VERACRUZ, MEXICO
(SERPENTES: COLUBRIDAE)

Abstract

Species of the genus *Tantillita* are restricted to Central America and extreme southern México. One of them, *T. lintoni*, occurs in Guatemala and Honduras (Smith and Taylor, 1945; Wilson and Meyer, 1982), but has not been previously recorded in México. Two specimens of this species have been found in isolated mountains in the region of Los Tuxtlas, southern Veracruz, and they exhibit characteristics, with evidence of geographic influence, distinct from those of the Central American populations. In the present paper, the recognition of two subspecific populations is proposed: one in Central America, and the other in the vicinity of Los Tuxtlas, Veracruz, México.

Tantillita lintoni rozellae, subsp. nov.

Type specimens. Holotype: No. 2336 (field 84152), adult male from Colonia El Bastonal, Sierra de Santa Marta, 900 m above sea level, Municipality of Catemaco, Veracruz, México, August 17, 1984, author coll. Paratype: No. 2337 (field 84177), adult male from the top of Cerro Egega, El Acuyal, 850 m, of the same Municipality, October 13, 1984, same coll. Both specimens in herpetological collection of the Estación de Biología Tropical "Los Tuxtlas", U.N.A.M.

Diagnosis. Similar to *T. lintoni lintoni*, but distinguishable by the ventral pattern and coloration. In *T. lintoni rozellae*, the dorsal color covers all the dorsal scale rows, and extends to a darker line at the edges of the ventrals, forming a narrow, wavy, longitudinal line on each side of the venter; a short, fine black extension follows the edge of each ventral (Figure 1). In Central American populations, the coloration extends only to the upper edge of the first scale row (see Smith, 1940). The dorsal color pattern is uniform reddish-brown, darkest on posterior third; ventrals orange and subcaudals yellow in live specimens. Tail short, fat. Ventrals 115-118; subcaudals 47-48. Frontal obtuse posteriorly, with minor penetration between the parietals as compared with *T. l. lintoni* (see figure in Smith, *loc. cit.*).

Description of holotype. Head similar to that of *T. l. lintoni*, except that the frontal penetrates between the parietals less than in the known specimens of that subspecies. One preocular; two postoculars; seven supralabials, third and fourth entering orbit; temporals 1-1; six infralabials; posterior chinshields smaller than anterior. Ventrals 115; anal divided; subcaudals 47. Total length 162 mm (body 122, tail 40). Dorsal color uniform reddish-brown, posterior part of body and tail darkest, involving all rows scale, a brown dark pigmentation on edges of ventrals, forming a notched, longitudinal dark brown line on each side of venter (Figure 1). Venter cream in alcoholic solution (ventrals orange and subcaudals yellow in life), except for a fine dark line at lateral edge of anterior margin of each ventral. Supralabials, except fourth, slightly pigmented.

Habitat. The specimens were found in areas of rain forest at 800 and 900 m above sea level, with more than 4000 mm annual rainfall and abundant fog. The holotype was collected in litter, the paratype under rocks. Both were found during the day. This habitat seems to be discrepant with the recorded, low altitude habitat of populations from Guatemala and Honduras (Smith, 1943; Wilson and Meyer, *loc. cit.*). The name honors Dr. Rozella B. Smith, of the University of Colorado, for her indefatigable contributions to the knowledge of the Mexican herpetofauna.

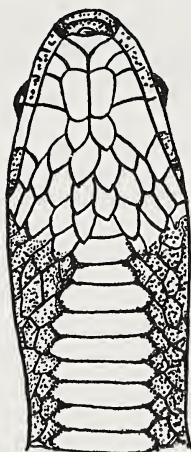


Figure 1. Ventral pattern of holotype of *Tantillita lintoni rozellae*, subsp. nov. See text for measurements.

Acknowledgements

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NEWS AND NOTES:

THE JARARACA AND ITS ROLE IN COMBATING HYPERTENSION

Many ironies exist in nature, but none possibly so fascinating as that of the Brazilian lance-head snake called *Bothrops jararaca*. The *jararaca's* venom can be fatal, and if it strikes a blood vessel it can kill a person very quickly since all the blood will coagulate in about twenty minutes. Because of this, lance-heads were formerly the terror of Brazil where they caused 3,000 fatalities every year.

As an example of the potency of the snake's venom, R. Ditmars tells of a plantation worker who was bitten in the leg and then brought home. ". . . his wife washed the severely bleeding wound with water. The man, who was treated by only a native 'snake doctor,' died after two hours. Tragically, however," Ditmars adds, "his wife also died the following morning with characteristic lance-head poisoning symptoms, even though she had not been bitten." What had happened to her? "Her fingertips had very small cuts caused by handling coconuts, and the deadly venom got into her system when she washed her husband's wound."

All of this is good and well but wherein, you may ask, lies the irony of a deadly snake? The irony is contained in the simple but very powerful fact that this same snake whose venom can kill a man in twenty minutes has the potential to save thousands or even millions of lives with that very same venom. It seems that a certain extract from the *jararaca's* venom named captopril can block the release of renin and thereby can work as a much-needed and very powerful drug to combat the common disease known as hypertension.

The story of the *jararaca's* venom is almost like a movie plot, whose elements include a mysterious disease that threatens millions of lives, a young scientist doing "pure" research in obscure laboratories, a highly respected scientist who clings stubbornly to an unpopular theory, and two drug company researchers who start fiddling with a small unimportant project and wind up working in secrecy on a product worth millions of dollars to their employer. The mysterious disease is hypertension (better known as high blood pressure).

In 90% of the 25 million Americans who have it, doctors can't find any internal defect to explain why their blood is being forced through their arteries at abnormally high pressure. And what adds to its obscurity is that it doesn't produce any noticeable symptoms, but kills via the steady pounding over the years that changes and damages the body, making its victims vulnerable to fatal strokes, heart attacks, kidney failure, and a host of other illnesses.

In the 1960s the kidney and its renin-angiotensin system became the prime suspect in the search for a cause for hypertension. Underlying this belief was a series of experiments dating back to the 1930s that revealed a chemical chain reaction that could increase blood pressure. The chain

reaction works this way: when the kidney senses a drop in blood pressure it releases the chemical renin. The renin immediately triggers in the blood the appearance of a second chemical called angiotensin I. As angiotensin I sweeps through the body, the tissues release an enzyme that converts it to a new form called angiotensin II.

Angiotensin II has a marked effect on blood pressure. In a second or two it constricts certain blood vessels much like the tightening of a nozzle on a hose. As the same amount of fluid tries to push through a narrower opening, the pressure rises. In addition to this quick effect, angiotensin II, over a matter of hours, also can cause the body to retain salt. When levels of salt in the blood begin to rise, water must be retained to dilute it or the effect can be fatal. The extra water increases the volume of blood. As more fluid tries to push through the blood vessels, pressure goes up. Researchers speculated that in hypertension the kidney was erroneously switching on the renin-angiotensin system, keeping blood pressure abnormally high. To test this theory they measured whether patients with high blood pressure had excessive renin in their blood.

However, no connection between renin levels and high blood pressure was found. Most hypertensive patients had normal levels, many had extremely low levels, and only a few had excessive amounts. As a result, the notion that the renin-angiotensin system was the key to hypertension was put aside.

A small group of researchers, however, remained intrigued with the renin-angiotensin system--and how it worked.

Among them was a Brazilian named Sergio Ferreira; he was interested in a substance in the blood that normally made vessels open up or dilate, but was rendered inactive when it passed through the lungs. He worked in the lab of a Dr. Vane, who was also fascinated by such chemical actions in the lungs, but for a different reason. He and a colleague had found that lung tissues seemed to be the source of the enzyme that converted angiotensin I to angiotensin II. Thus, it seemed that something in the lungs broke down one chemical that kept the blood vessels open and produced another that constricted them.

Enter the *jararaca* venom. Dr. Ferreira, following up on some research done by Dr. Vane, found that a crude extract of the venom would stop the lung from breaking down the vessel-dilating substance. And later they found that the same venom extract blocked the conversion of angiotensin I to angiotensin II, thus preventing the constriction of blood vessels.

After this discovery it was realized that the venom was the key to determining how important the renin-angiotensin system was in controlling blood pressure. If they could isolate the venom's active ingredient, they could inject it into animals and eventually humans, block the final conversion to angiotensin II, and see what happens to blood pressure.

So the search began not only in Dr. Vane's laboratory, but also at the Squibb Institute for Medical Research, a drug company. Squibb had undertaken the project because Dr. Vane, an advisor to the institute, had impressed them

with its importance. They, however, lacked enthusiasm for it not only because of the prevailing view that this renin-angiotensin system isn't an important factor in hypertension, but also because the mystery ingredient in the venom was probably a peptide which would never reach the bloodstream intact.

Any drug that had to be injected into the bloodstream two to three times a day would never sell for a condition like hypertension where life isn't immediately threatened.

But nevertheless, the project was taken on and after much tedious work, a small peptide was found which they dubbed SQ 20,881.

They tried it first in the test tube, then on animals, to see whether it worked to block the conversion of angiotensin I to angiotensin II--it did. They then tried it on six healthy male volunteers. The peptide prevented an injection of angiotensin I from raising the volunteers' blood pressure, good evidence that it blocked the conversion to angiotensin II.

These findings, published in 1973, delighted Mr. John H. Laragh, a cardiologist in New York working at Cornell Medical College. He and his colleagues had just found that a widely used hypertension drug called "propranolol" actually worked by interfering with the production of renin. This convinced Dr. Laragh that the kidney lay at the heart of the hypertension problem.

By 1973, however, Dr. Laragh was fighting a rather lonely battle to keep his theory alive. Therefore, to Dr. Laragh, SQ 20,881 was a godsend. If hypertensive patients' blood pressure went down when they were injected with the peptide, it would be strong evidence that the renin-angiotensin system was the source of the disease.

The experiments began with patient volunteers. In less than an hour after injection, blood pressure began dropping. It worked in patients with normal renin levels and no better in high renin patients. It appeared that SQ 20,881--or something like it--would be effective in 70% of people with essential hypertension. But it was difficult to extract much peptide from the venom, and it was expensive.

New research, shrouded in secrecy, was started by Squibb. The research involved an entirely new approach to developing a new drug. Until 1974 they followed a fairly conventional approach in searching for a pill that would do what SQ 20,881 did by injection. This was to study reports on thousands of non-peptide chemicals that had been synthesized over the years, hoping to find one that had shown some hint of being active in blocking angiotensin. If found, chemists could perhaps tinker with the compound's molecular arrangement, enhance desired activity, and decrease its undesirable effects. The search unfortunately proved fruitless.

However, nature had provided them a clue: an enzyme in the pancreas gland involved in digestion--which scientists had studied for decades--worked on the same principle as the angiotensin-converting enzyme. And there existed a chemical that would render the digestive enzyme inactive.

Using the digestive enzyme, the Squibb researchers proceeded to build a chemical that would inhibit the angiotensin-converting enzyme. The results produced "Captopril." It worked not only in the test tube, but also with animals. Squibb later got permission from the U.S. Food and Drug Administration to begin testing the drug on human patients.

In the patients, particularly those with high amounts of renin in their bloodstream, pressure began dropping within 15 minutes after taking the drug. Today Captopril has been used in over 3,000 patients so far and has proven to be effective.

So there you have it--if not for the venom of a snake, most dangerous to man, they would never have had the key that helped unlock the door to the cause of hypertension--an irony of nature.

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NEWS AND NOTES:

A BRIEF REVIEW OF THE CAREER AND WRITINGS
OF T. PAUL MASLIN, 1909-1984

Although T. Paul Maslin (Oct. 27, 1909 - Feb. 26, 1984) is widely recognized as the most eminent of authorities on the herpetology of Colorado, and as one of the earliest workers on parthenogenesis in *Cnemidophorus*, the actual diversity and significance of his activities are little appreciated. We here briefly review his contributions and present as complete a list of his publications as possible.

We are much indebted to Mr. Andrew Pierce, Asst. Director of the Denver Botanic Gardens, for invaluable help in ferreting out Maslin's botanical publications and related material. Dr. James R. Dixon was especially helpful in herpetological contexts, and Mrs. Mary Maslin, Dr. Sam Shushan, Dr. Shi Kuei Wu, Dr. Wm. E. Duellman, and Dr. C. J. McCoy also aided in extending our coverage of all fields of Paul's endeavors.

Paul did not make easy a survey of his published contributions, for he spurned abstracts, never listing them in the periodically demanded vitae; ceased to list anything appearing after 1971; never kept track of his botanical articles; and even omitted a few herpetological articles as, presumably, too insignificant to mention. His interests were so varied that he was not dependent for self-satisfaction upon extraction of every possible recognition for any given area of endeavor.

Clearly his two most consuming interests were herpetology and rock garden horticulture, the latter burgeoning after retirement in 1973. Although most of his professional life was devoted to herpetology, in which his contributions far exceeded those in botany, he was adulated and honored more for the latter than he ever was for his herpetological work. The first botanical honor was the annual Marcel Le Piniec award of the American Rock Garden Society at its national meetings in Boulder, on July 3, 1982, "...for both taxonomic clarification in *Phlox* and, even more, for starting a new race for *phlox* which promises to have a bright future in horticulture and rock gardening in particular." (Deno, 1982:192).

The second botanical honor was an award of Dec., 1983, when Maslin was extremely ill, from the Rocky Mountain Chapter of the American Rock Garden Society, "...in recognition of, and gratitude for, distinguished service to rock gardening in Colorado and to the Rocky Mountain Chapter, as one of its principal organizers, founding members and as its first chapter chairman; provision of enduring inspiration and an outstanding exemplar of our art; introduction and testing of countless plants new to the region and to horticulture; and for unstinting sharing of knowledge and plants." (From the dedication).

Maslin's botanical publications, and several articles about his botanical work, are listed in the accompanying bibliography. His works in

this area are not voluminous, yet he evoked a proportionately astonishing, sincere adulation of not merely regional but international scope. Why the discrepancy between reaction of his peers in botany as compared with herpetology or zoology?

It seems likely that the reason is that he brought to an extensively, although not wholly, amateur (at least non-professional) group interested in rock gardening the attributes of an experienced researcher - a tenacity and thoroughness of investigative skills unusual among amateurs. In that milieu his native generosity and warm kindness flowered unfettered by the constraints that beset fields of endeavor populated by many skilled investigators. Admiration for his achievements was unsullied by jealousy and led to a cybernetic mutuality of feeling that is often difficult to achieve in purely professional contexts.

The fervor with which Maslin pursued rock gardening was evidenced not only by his own superb garden, and by his research and local activities, but by frequent attendance at both national and foreign rock garden society meetings. He was internationally recognized. In addition he was a member of the Men's Garden Club of Boulder.

One of Maslin's most fundamental attributes was his artistic talent, of exceptional magnitude. He never exploited it extensively, but it was evident in the sculptures, carvings and paintings he made for his own pleasure; some are truly exquisite. His woodworking shop at home was of professional caliber, and in it he made superb furniture. He built and developed his own home (except for the basic frame), created his rock garden from scratch, built a beautiful stone wall, with sculptures, around part of the yard, and added extensive stonework for a garage and patio. The property is as a result one of the most attractive in Boulder.

Not surprisingly, his artistic drive influenced his professional as well as extracurricular endeavors, leading him to careful planning of experiments and field trips so that they were predictably successful. Photography became an obsession early in his career, resulting in thousands of 2 x 2 color transparencies (all of zoological import now on file in the University of Colorado Museum, all on botany - over 3,000, all meticulously labelled - in the Denver Botanic Gardens). He was an assiduous note-taker on field trips and other journeys, filling a dozen or so notebooks (also now in the CU Museum). His artistic interests also led to joining several related Boulder organizations, such as the Art Association, Artists' Guild, Lens Club, Community Players, P.T.A., Chamber of Commerce, and Philharmonic Association.

Although basically a herpetologist, Maslin was a general zoologist, trained and capable in theoretical as well as factual aspects, articulate in exegesis aided by a thorough comprehension. He had a good mind that enabled him to understand abstruse concepts, as exemplified by his articles on morphological criteria of phyletic relationships, the nature of amphibian and reptilian species, and taxonomic problems in parthenogenetic vertebrates (H14, H23 and H44, respectively, of the following bibliography). These three

articles have been widely cited in zoological literature, foreign as well as domestic.

Because of articulate expression and thorough understanding of the subjects dealt with, Paul was an outstanding teacher, with the highest rating at Colorado State University (where he taught for two years before coming to the University of Colorado) of anyone appraised up to that time, and being the frequent recipient of gifts from his students at CU in appreciation of his effectiveness as a teacher. He had supervised more graduate students at CU than any other member of his department before he transferred full time to the CU Museum in 1966. Among the graduate students he launched on their careers are Kathleen Beargie, James Campbell, Orlando Cuellar, Wm. K. Davis, Alvin Earle, Herman A. Fehlmann, John Ferner, Richard Holland, H. Jones-Burdick, Gary Knopf, C. J. McCoy, Lewis Pennock, Robert Reese, Diane Secoy, Harry Taylor and James Walker, all with notable or outstanding contributions to their credit. He is still remembered as one of the two or three best teachers encountered by students in their entire college careers.

Teaching was, however, an at least part time occupation even from the time Maslin was 17 years old, nurtured by his early years in China and his missionary parents. He served as an ad hoc tutor as early as 1927, and continued doing so until he received his Ph.D. degree. Full-time teaching began in 1933, as he taught for three years at the high school level, in biology, mathematics and physics. After receiving his master's degree in 1939 (Univ. California, Berkeley), with a teacher's certificate, he taught at Armstrong Junior College in Berkeley for a year, in anatomy, biology, physiology and chemistry. As he pursued his Ph.D. at Stanford University (1941-5) he assisted or instructed in Comparative Anatomy, Invertebrate Zoology and Ornithology. At Colorado State University and the University of Colorado he taught General Biology, Comparative Anatomy, Advanced Comparative Anatomy, Herpetology, Evolution and a graduate course in Modern Theories of Evolution. He was prepared to teach numerous other courses, e.g., Vertebrate Taxonomy, General Biology, General Zoology, Embryology, Zoogeography, Museum Techniques, Invertebrate Zoology, Microtechnique, Organ Physiology, Ecology, Ornithology, Histology, Cytology, Cell Physiology, Experimental Embryology and Genetics. Such versatility is today almost inconceivable, but it explains the breadth of interest and expertise he demonstrated in herpetology. He was definitely not just a taxonomist, or any other limited specialist.

In California Maslin laid the foundation for his museum expertise, serving as curatorial assistant for three years (1937-1940) in mammalogy at MVZ under E. Raymond Hall and David Johnson; the same for four years (1936-1940) in herpetology at MVZ, for two years (1941-1943) at Stanford University; the same for two years (1941-1943) in ichthyology at Stanford; and the same for one year (1939) in ornithology at the California Academy of Sciences. He worked with Alden H. Miller in 1938, and with George S. Myers for his doctoral degree. His mentors thus included some of the most famous of the Berkeley and Stanford zoologists. Under their direction he supervised many student aides in the museums at both Berkeley and Stanford, and for a

year coordinated the work of 30 WPA workers at the California Academy of Sciences with Joseph Slevin (1939-1940).

The strangest of Maslin's employments was the year he spent (1944-5) as Port Supervisor of San Francisco, in the Office of Fishery Coordination, overseeing (with two assistants) the processing of 120,000 tons of sardines, among other duties. His years in California were maddeningly hectic but provided an impetus for diverse, intelligent and energetic application in the security afforded by the appointments that followed at Colorado State University (1945-1947) and the University of Colorado (1947-1984).

As a member of the University of Colorado, Maslin was an enthusiastic participant in many aspects of its operation; he was not more of a recluse there than in his non-professional activities. Of primary importance were his roles in his Department of Biology (later designated the Department of Environmental, Population and Organismic Biology, when the Department of Molecular, Cellular and Developmental Biology was created) and in the Museum.

In his Department Maslin served in numerous capacities other than in teaching; most important was his role as Acting Chairman (1961-1962), but he served on dozens of committees, often a half dozen or so each year.

In 1966 Paul was transferred full time to the Museum, where he had held a nominal appointment since 1947. When he arrived on the scene the herpetological collection of the Museum had a meager 1200 specimens, lacking any systematization. Maslin organized the collection and by the time of his retirement had increased it to some 60,000 specimens, admirably curated and housed. He also served as Acting Director for a time, and on several Museum committees, even before becoming a full-time member. Teaching continued with annual presentation of a course in herpetology.

Active as he was in the Department and Museum, his services to the University as a whole were even more varied, with a half-dozen committees or appointments a year added to his other duties. He served numerous roles in the University Senate, the Graduate School, the Library, the College of Arts and Sciences, as liaison with the Medical School and state high schools, and as supervisor of an NSF Undergraduate Scholarship.

Outside of the University, professional ties were numerous. Maslin held several offices at different times with the Colorado-Wyoming Academy of Science, the Southwestern Division of AAAS, and the AIBS; gave numerous lectures and seminars to various local organizations; worked with the National Association on Standard Medical Vocabulary; and was an invited participant in several symposia.

The overwhelming burden of these ancillary professional obligations occupied an enormous amount of time, making it surprising that Maslin managed to publish as much as he did. Yet the immensity of his varied contributions was recognized by the University, which awarded him two Faculty Fellowships (1958, 1966) and numerous small research grants. His stature was also demonstrated by receipt of at least five NSF grants, and others from the University Museum and Thorne Ecological Foundation.

The grants, fellowships and other research support received were devoted mostly to field work, although some funds were allocated to laboratory equipment and research. Travel was always a great addiction; not only were there at least six expeditions to mainland Mexico, three to the islands in the Gulf of California, a half dozen to southwestern United States, two to British Columbia, two to Oregon, one to the Galapagos Islands, Netherlands Antilles and Venezuela, and another to Peru, but dozens of in-state trips, often with classes, in California and Colorado, numerous trips to England, one to western Europe (including East and West Germany, Netherlands, Italy, France), one to Japan, another to China, and one to the East Indies. Throughout most of his postdoctoral career he attended several (usually three) scientific meetings (Soc. Study Evolution, AAAS, AIBS among them) each year, although, strangely, relatively few were herpetological (only one of HL/SSAR). He was especially active in the Southwestern Association of Naturalists (member at least 1963-1975, associate editor and governor 1967-1971) and the Colorado-Wyoming Academy of Science (member since 1948, section chairman 1959, 1969). To facilitate travel he purchased an excellent field vehicle, for which he designed and constructed a field kit (see H50 of the accompanying bibliography); through his influence the Museum acquired all essential equipment for field work as well as laboratory study.

Despite these diversions, Maslin managed to maintain an impressive research and writing program in herpetology and related fields. Most of his works are of lasting significance, beginning with his separation of *Bothrops* and *Trimeresurus*, the discovery of the previously overlooked nasal pore of both genera (all species of *Trimeresurus*, as he defined the genus), and his key to members of the latter genus (no. H2 of the accompanying bibliography). The review of the snakes of the Kiukiang-Lushan area of China (H10) is one of the few regional works on Chinese snakes in English, following Pope's review of 1935.

The article on sound production in salamanders (H11) is a thorough, scholarly review of the literature and an excellent histological study that has never been superseded.

His theoretical accounts of morphological criteria of phyletic relationships (H14) and of the nature of species in reptiles and amphibians (H23) reveal an admirable command of difficult concepts, and continue to be quoted in current literature. The former article has been honored by a reprint in the Benchmark Papers in Systematic and Evolutionary Biology series, in a volume on cladistic methodology now in press, edited by Tod Stuessy and Thomas Duncan, published by Dowden, Hutchinson and Ross, Inc., of Stroudsburg, Pennsylvania.

The 1959 review of the herpetofauna of Colorado, with its precise listing of localities for every species-group taxon (H24) is another classic that remains indispensable for detailed studies in the state on amphibians or reptiles. His notes on the Yucatán herpetofauna (H28) and tadpoles (H29) are basic to faunistic and tadpole studies in that area even today, as one of the few thorough surveys of the region.

The most dramatic of Maslin's discoveries was the occurrence of parthenogenesis in several species of *Cnemidophorus*, first announced in 1962 (H26). Although one species of the genus (*C. tessellatus*) had been thought to be parthenogenetic as early as 1958 (Minton), Maslin extended the list to six taxa. His meticulous subsequent work confirming parthenogenesis by skin transplants (H42) and hatching of eggs (H40) is without parallel in concept and execution, and provides irrefutable evidence of the phenomenon. The theoretical reviews of the taxonomic implications of parthenogenesis (H44, H49) are scholarly products of his personal encounters with such problems. Drawn into a study of the genus by its unisexual taxa, Maslin energetically studied its members in both the laboratory and the field, concentrating upon Mexico and especially the islands in the Gulf of California. Numerous articles by him and several of his students (Beargie, McCoy, Secoy, Taylor, Walker) resulted, culminating personally in the thoroughly annotated checklist of all species-group taxa now recognized in the genus (H56).

In addition to these published works, Paul produced a spate of mimeographed materials, and so did some of his students, of anatomical and herpetological nature. They included numerous editions of a checklist of the herpetofauna of Colorado; diagnoses and keys to all the higher categories of extant amphibians and reptiles; laboratory directions for dissecting the American alligator; a summary of the herpetofauna of the Beecher Island area of Yuma Co., Colo.; and lists of major reference works on amphibians and reptiles. He finalized directions written by two of his students for dissection of the thigh musculature of selected anurans, and for study of the skull of *Ctenosaura*.

More than any other person, Paul drew attention in newspaper accounts and in his review of the herpetofauna of Colorado (H24) to the highly intriguing anecdotal evidence of the existence of *Bipes* in the Platte River valley - an enigma that remains today unsolved.

Retirement was a period of thorough enjoyment in the pursuit of many interests, with very little attention to herpetology. Paul's energy scarcely waned as he worked vigorously on his rock garden, stone wall and woodworking, interspersed between numerous trips all over the world. Not until the summer of 1983 was there any sign of deterioration of health or energy.

Honored as Maslin was for his horticultural and academic achievements and services, it is a travesty that, in the specific field in which his greatest contributions came, little recognition followed. That he may fare better posthumously is suggested by the Benchmark recognition of his seminal article on morphological criteria of phyletic relationships.

The following bibliography of Paul Maslin's publications is almost certainly not complete, for reasons stated previously. It is, however, as complete as we can make it with the help of our acknowledged colleagues.

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B. Mammalogy

- M1.1983. Fringed-tailed bat in British Columbia. *J. Mamm.*, 19:373.

C. Botany

- B1.1950. Three hardy bulbs. Green Thumb, Denver Botanic Gardens, 7(6):27-29.
- B2.1978. *Phlox nana* Nuttall. Quart. Bull. Alpine Garden Soc., 46(2):162-167, 2 figs.
- B3.1979. The rediscovery of *Phlox lutea* and *Phlox purpurea*. Bull. Am. Rock Garden Soc., 37(2):62-69, figs. 1-2 (color).
- B4.1981. China - a sentimental journey. Green Thumb, Denver Botanic Gardens, 38(3):92-96, 2 figs.
- B5.1983. Some fall blooming bulbs. Bull. Am. Rock Garden Soc., 41(1):32-35, 1 fig.
- B6.1983. China - a sentimental journey. Bull. Am. Rock Garden Soc., 4(2):89-93, 2 figs. (Essentially a reprint of no. 4, but with one different figure and several minor changes of wording).



Figure 1. T. Paul Maslin in his preferred working garb, on the patio of his house in Boulder, 1969 (an auto-exposure).

No articles eulogizing Maslin appeared during his lifetime in any journals of herpetology, his most important field of activity, but three appeared in botanical journals, all celebrating his pioneer work in the introduction of certain varieties of *Phlox* to horticulture, as follows:

Foster, Laura Louise. 1979. ...of cabbages and kings...Bull. Am. Rock Garden Soc., 37(2):92. (A recount of the first public announcement of rediscovery of certain red and yellow varieties of *Phlox*, and of the history of publication of the article (no. B3 above) about it, with its figures in color).

Robertson, Josephine. 1982. The *Phlox* adventure. Green Thumb, Denver Botanic Gardens, 39(2):55-57, 1 fig. (A brief recount of the rediscovery of the same *Phlox* varieties discussed in Maslin's article (no. B3 above), with an update on subsequent cultivation, and comments on Maslin's personal rock garden, said to be "the most distinguished private garden of its kind between the midwest and the coast." Another article by the same author, "One man's rock garden in the Rockies," will appear in the spring, 1985, issue of "The Horticulturist").

Deno, Norman. 1982. Le Piniec award: T. Paul Maslin. Bull. Am. Rock Garden Soc., 40(4):191-192, 1 fig. (Brief biographical notes and a statement of basis for granting the North American Rock Garden Society's 1982 Le Piniec Award for outstanding contributions to rock garden cultivation, to Maslin).

The first obituary published in a professional journal appeared in the April, 1984, Green Thumb Newsletter of the Denver Botanic Gardens (no. 84, for April, p. 4). Another is in Copeia, 1984(No.3:86-87, fig. 1).

—Hobart M. Smith and Rozella B. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado 334, and Center for Computer Research in the Humanities, University of Colorado 226, Boulder, Colorado 80309.*

Received: 16 October 1984

Accepted: 24 October 1984

NEWS AND NOTES:

BOOK REVIEW:

THE MOCKERY BIRD. By Gerald Durrell. Wm. Collins Sons & Co., Ltd., 14 St. James Place, London SW1A 1PS. 224 pp. 1981. Fontana Paperbacks, 1983. \$1.50.

Gerald Durrell is already famed as the greatest living writer in natural history. He may well be the greatest of all time. For some these may be contentious words, but they are not lightly written. The sheer volume of his books (some 25 titles), their consistently captivating charm, diversity and laudatory goals (support of his field work and, in later years, of his great zoo on Jersey, Channel Islands), and their enormous popularity, particularly in Britain, attest to their unparalleled excellence. Durrell not only has travelled widely, has had a lifetime of experience with zoos, and has an intense drive to know animals of all sorts, but he is a masterful raconteur - a spell-binder of exceptional skill. No one who claims to be interested in natural history, or in any of its innumerable ramifications, can fully appreciate the meaning of the subject without reading at least a few of his books, most importantly his classic first one, "My Family and Other Animals," 1956. Few will want to stop with that book, once having sampled Durrell's matchless style; most become addicted and pursue every volume relentlessly.

Most of Durrell's books are factual narratives of his many experiences collecting far and wide, or caring for animals in captivity, or living with the fascinating characters who peopled his life. A very few unleash unrestrainedly his ebullient enthusiasm as he yarns with a soaring imagination that would do justice to the best novelists.

The present book is one such, centering upon the imaginary island of Zenali in the Indian Ocean. However remote from fact it may be, I regard it as his most important work, for it is a detective story directly concerned with conservation, to which Durrell's life has been devoted for several decades. It is perhaps the first conservation novel, and it is a superb one that every organismic biologist owes it to himself to read. Be not perturbed by the fancied situation; many a parallel exists in fact, as stated in the ending "tailpiece" of the book. The message is a valid, timely and vital one in the context of intelligent conservation.

To be sure, there is little of strictly herpetological nature in the book, contrary to expectation of reviews appearing in this journal. At least *Phelsuma*, the genus of day-geckos, is mentioned. But this deficiency is insignificant, for the message is as pertinent to herpetology and herpetologists as to any other aspect of biology; it is a book for all seasons. Don't miss it.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado 334, Boulder, Colorado 80309*

Received: 10 August 1984

NEWS AND NOTES:

BOOK REVIEW:

RATTLESNAKES. By G. Earl Chace. Dodd, Mead and Co., 79 Madison Ave., N.Y., 10016; 64 pp., 111. (monochrome). \$7.95. 1984.

In 1975 another book by Chace was published on rattlesnakes: "Wonders of Rattlesnakes." The more recent book is shorter, more clearly directed toward the juvenile reader, and is quite different in approach, following the life of one snake (a Prairie rattlesnake) from birth to maturity. A final chapter briefly reviews a few other kinds of rattlesnakes. Thirty-six photographs, including several from his earlier book on rattlesnakes, enliven the pages and add useful information and visual concepts. Wisely, no discussion of snakebite treatment is ventured; instead the reader is exhorted to leave all rattlesnakes, even dead ones, strictly alone.

There is much less detail in this book than in the earlier one, but no new information, other than photographs, is added. Its appeal accordingly is to the beginning reader.

The account is basically sound, with no notable errors of commission aside from a lapsus in spelling of the species-group names of the Prairie rattlesnake, placement of *oreganus* at specific instead of subspecific rank, improper usage in discussion of species-group ranks, and estimate of "kinds or species" of rattlesnakes as "60 or more" (about 32 species or 88 species-group taxa are known). These are insignificant faults in comparison with the abundance of correct information and concepts offered in the book, especially in view of its intended readership.

Nevertheless a great deal of information on life history and behavior of rattlesnakes in general and the Prairie rattlesnake in particular has been unearthed in recent years, particularly by Chiszar and Duvall, that would be of interest even to juvenile readers. It would make a fascinating addition to any further book, at any level, that may be considered in the future on rattlesnakes.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado 334, Boulder, Colorado 80309.*

Received: 8 September 1984

NEW BOOK NEWS:

NEW BOOK RELEASES:

INDEX TO THE GENERA OF AMPHIBIA--A DEVICE TO ASSIST CURATORS. Fourth Edition. 30 July 1984.

This index is privately produced, 8½ x 11 inches, and 41 pages plus stiff paper covers. Included are all available generic names within the living families of amphibians. Each name is followed by author(s), year, and, in the case of synonyms, the currently accepted valid name. The index has two parts, a straight alphabetical list of all the genera and the same names grouped by families.

A limited number of copies are available at cost. For each copy please send \$2 plus \$1 for handling to:

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LIONS AND TIGERS AND BEARS. A Guide to Zoological Parks, Visitor Farms, Nature Centers, and Marine Life Displays in the United States and Canada. By Jefferson G. Ulmer and Susan Gower.

Here is the most comprehensive visitor-oriented guide to live-animal exhibits in the United States and Canada. This book will be of use to those considering a trip to any of the more than 850 listed parks and display areas. All institutions with permanent onsite animal collections open to the public are included.

Wildlife lovers will find entries for zoos, aquariums, reptile displays, fish hatcheries, aviaries, demonstration farms, wildlife research facilities, game farms, and children's museums.

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Teachers, students, Scout Leaders, church groups, 4-H members, tour organizers, job seekers, park service companies, and all libraries, will benefit from the timely and concise information found in Lion and Tigers and Bears.

Lions and Tigers and Bears may be ordered directly from Garland Publishing, 136 Madison Avenue, New York, NY 10016 (212/686-7492). Review copies may be ordered upon request. Hardcover ISBN 08-240-8770-4, \$20.00.

NEW BOOK NEWS:

NEW BOOK RELEASE:

THE LIFE OF DESERT REPTILES AND AMPHIBIANS. Produced and distributed by Karl H. Switak, Nature Photography-Publisher, P.O. Box 27141, San Francisco, CA 94127. Suggested Retail Price \$4.95.

Thirty-two pages in full color. All animals photographed in their natural habitat. The only publication dealing specifically with the care and keeping of desert reptiles and amphibians from the southwestern U.S., northern Mexico, and parts of Baja California.

Such important facts as temperature tolerance, water requirements, nutritional balance, proper cage set-ups, compatibility with other species and much more factual information is supplied for each individual variety of lizard, snake, tortoise, and amphibian.

The easy to follow index pin-points a subject matter quickly, there are two pages for notes in the back, plus a paragraph on the law regarding collecting and keeping.

The book is 6" x 9" with a semi-hard cover, depicting the Trans-Pecos rat snake in full color on the front.

Several habitat photos, all in realistic color, show exact locales for many species of reptiles and amphibians.

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NEW BOOK NEWS:

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THE SNAKES OF AUSTRALIA. An illustrated and descriptive catalogue of all the known species. By Gerard Krefft, 1869. Facsimile Edition, 1984. \$52.00 (Australia); \$55.00 (Overseas).

'The present descriptive Catalogue contains a full account of nearly all the Australian Snakes discovered and recorded up to the year 1869, including the Sea Snakes observed on our coast. Original descriptions have been retained wherever it was possible, errors have been corrected, and the ranges of the various species defined. Much attention has been paid to the colours of living specimens, and to the changes ophidian reptiles undergo during the period of growth. Frequent experiments have enabled me to distinguish between venomous and dangerous venomous snakes; and it must be a source of congratulation that, with the many new discoveries in this branch of Natural History during the last ten years, not one really dangerous serpent has been added to our fauna.' ...*Gerard Krefft, 1869*

Krefft was Curator and Secretary of The Australian Museum, Sydney, 1861-1874. His magnificently illustrated book 'The Snakes of Australia...', is the first detailed study of Australia's fascinating snakes.

Only 1,000 copies of this high quality facsimile edition have been printed. The book is on fine quality paper. It contains 100 pages and includes 12 had coloured lithographs which have been reproduced faithfully. Krefft's work makes fascinating reading. Anyone interested in natural history (especially Australian reptiles) will find it a very worthwhile purchase.

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NEW BOOK NEWS:

NEW BOOK RELEASE:

SAFARI: THE EAST AFRICAN DIARIES OF A WILDLIFE PHOTOGRAPHER, photographs by Gunter Ziesler and diary notes by Angelika Hofer, is a book as dazzling as the subject it describes (Publication date: September 7, 1984; Price: \$24.95).

Ziesler, one of the world's most renowned natural history photographers, and Hofer, a zoologist with a specialty in animal behavior, spent a full year documenting the drama of the lives of African wildlife.

There are many books containing photographs of African wildlife, but few, if any, demonstrate the extraordinary results of so many hours, days and months spent waiting patiently to get the perfect shot. Patience, as consulting editor Nigel Sitwell says in the Introduction, is probably the most important attribute of a wildlife photographer.

Living and travelling in a converted VW van, Ziesler and Hofer visited the remote habitats of the Masai Mara, Amboseli and the Chyulu Hills. Their mobile homes often served as a blind from which Ziesler studied at close quarters and recorded on film some of the most remarkable animal life to be found anywhere in the world. His attention to detail and skill at composition have produced a collection of images that is truly magnificent.

Hofer's vivid descriptions of the places visited and the sights, sounds and smells of the animals encountered perfectly complement the photographs and enable the reader to share the great excitement of first hand observations in the field. As a trained ethologist, she places the actions of the animals seen in the photographs in the context of species and behavior and evolutionary development.

Reading these diaries and looking at these photographs is almost like witnessing the dramatic spectacle of migrating wildebeest herds, a pride of lions on a hunt or the rarely seen event of a python unhinging its jaws to slowly engulf a gazelle.

GUNTER ZIESLER is a professional wildlife photographer who has travelled widely in the course of his work. He has undertaken extensive expeditions to South America, the Galapagos Islands, Spain, New Guinea, Africa and, most recently, to India. His work is published in wildlife magazines and books throughout the world.

ANGELIKA HOFER is a zoologist with a particular interest in animal behavior. She studied ethology at the Universities of Regensburg and Munich, and has accompanied Ziesler on his photographic trips to Spain, Sweden, the Netherlands, Africa and India.

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For more information, contact Bennett C. Petrone.

NEW BOOK NEWS:

NEW BOOK RELEASE:

THE HERPETOCULTURIST. Published by the Reptile Breeding Foundation,
P. O. Box 1450, Picton, Ontario, Canada K0K 2T0. Telephone 613/476-3351.

The Reptile Breeding Foundation is pleased to announce the forthcoming publication of the journal, The Herpetoculturist: a periodical devoted exclusively to the husbandry and propagation of amphibians and reptiles in captivity.

Initially, The Herpetoculturist will be issued as the house publication of the Reptile Breeding Foundation, and, as such, will include news and information on their propagation, education and conservation projects. However, it is our intention, with support from the herpetocultural community, to eventually publish a quarterly journal, which will be of value to, and reflect the interests of all within that group.

Our inaugural issued is scheduled for January 1985 and we are presently soliciting articles for inclusion in this first and future issues. All papers must deal directly with captive husbandry or maintenance of reptiles and amphibians. Topics such as cage design and record keeping are acceptable, as they relate to the study of herpetoculture.

It is our hope that this publication will provide the amateur and professional herpetoculturist with updated and valued information on their animals. For further information, please contact us at the address listed below.

Subscription rates have not been established at the present time, but if you would like to receive our first issue, please provide us with the following:

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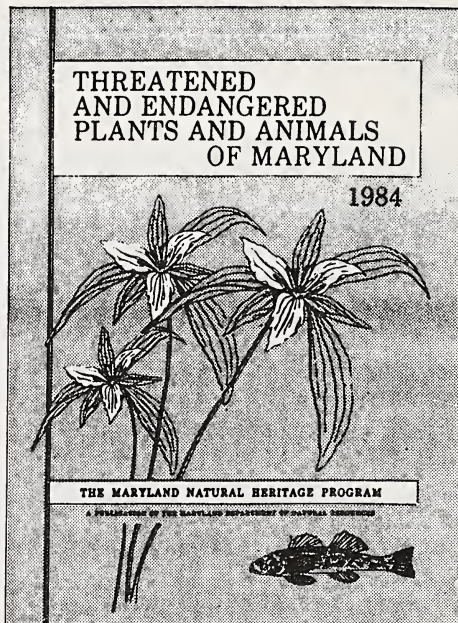
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NEWS AND NOTES:

THREATENED AND ENDANGERED PLANTS AND ANIMALS OF MARYLAND

PROCEEDINGS OF A SYMPOSIUM
HELD SEPTEMBER 3-4, 1981,
AT TOWSON STATE UNIVERSITY,
TOWSON, MARYLAND

Published by the Maryland Natural Heritage Program, this 476 page book contains thirty separate papers dealing with Maryland's rare plants and animals. Included are 22 papers presented at Towson State University in 1981, and eight others invited subsequently. All papers were fully revised and updated prior to publication. This is the first such publication for Maryland and should be an invaluable resource for naturalists, land use planners, and anyone interested in our threatened and endangered biota, or state and federal regulations concerning its management. The table of contents is reproduced on the back of this page.



Please send _____ copy(ies) of Threatened and Endangered Plants and Animals of Maryland @ \$13.00 per copy (price includes tax and postage). Enclosed is a check or money order payable to the Maryland Department of Natural Resources for \$ _____. Please send book(s) to:

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NEWS AND NOTES:

ANNOUNCEMENT:

HERPETOLOGY WEEKEND AT TERRA ALTA, WV

There'll be some excellent "herpin'" in the mountains of West Virginia this summer at our annual Herpetology Weekend. If you're a beginner or an experienced herper, this is a rare opportunity. The leaders will introduce you to the field and be your guide to the incredible diversity of amphibians and reptiles of the region. The leaders, Dr. Robert Gordon of West Liberty State College, Dr. Martin Rosenberg of Case Western Reserve University, and Dr. Joe Butler of Wheeling College, are all experts and are familiar with the area.

The weekend starts at 8:00 p.m. on Friday with an instructional slide program on the Amphibians and Reptiles of West Virginia. There will be night hikes to search for salamanders, visits to Dolly Sods and Seneca Rocks and explorations of unique cave habitats.

Field guides, identification keys and collecting equipment will be available. And don't forget to bring your camera because there will be frequent photography sessions.

So, if you're a fanatic or just curious about reptiles and amphibians, this weekend will be sure to please!

Where: Oglebay Institute camp on Lake Terra Alta,
Terra Alta, WV

When: June 7-9, 1985
Arrival Time: 6-8 p.m. Friday
Departure Time: 3 p.m. Sunday

Cost: \$40.00

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Oglebay Park
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The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.



DISTRIBUTIONAL NOTES ON SOME DELAWARE SNAKES,
WITH TWO FIRST RECORDS FOR THE STATE

Rudolf G. Arndt

Abstract

Locality data are given for seven species of little-known or secretive Delaware snakes. Although all species considered herein have been recorded for Delaware in range maps by Conant (1975), specific localities for two of the species have not been published. Data for five other species herein augment those in the literature and help to more accurately define their Delaware distributions.

Published information on the distribution of the herpetofauna of Delaware has been summarized and augmented primarily by Conant (1945, 1947, 1958). Additional data have been presented by Arndt (1972, 1975, 1976, 1977, 1978). As part of a continuing study of the herpetofauna of Delaware and adjacent areas by these two individuals, it seems desirable to now update information on the distribution of seven species of little-known or secretive Delaware snakes.

Many of the specimens or data reported on below have previously been made available to Roger Conant by me or by others and these data have been incorporated in Conant (1975). The Delaware range for each species considered herein and as known to me has thus already been published. The purpose of this paper is to present the first specific locality data for two of the species, and to augment locality data for five additional species. These data help to better describe the distribution of the snakes of Delaware. Further, with the recent advent of a nongame species program in the state, these data will help identify and hopefully safeguard known or possible populations of the less common species.

The data presented herein are based only on specimens or other documentation recently in my possession, and on literature records; museum and other records will be included in a later work. Data for Delaware will ultimately be related to that for adjacent states (e.g., summaries for Maryland by Harris, 1975, and for Pennsylvania by McCoy, 1982).

Many individuals contributed to this paper. In particular, Michael J. Geiger and Raymond M. Pusey provided many specimens and data; the former also provided numerous photographs. Specimens have also been contributed by Charles E. Mohr, Delaware State College, Dover; Thalia C. Putney, Wilmington Friends School, Wilmington; and Roland R. Roth, University of Delaware, Newark. Data have been provided by E. Paul Catts, Washington State

University, Pullman; David J. Cretty, Trap Pond State Park; Max. M. Harrell, Wilmington Friends School; and James F. White, Delaware Nature Education Society, Hockessin. Contributions of the above persons are credited below. Roger Conant kindly checked his records for certain species, and made valuable editorial comments. I thank the Department of Natural Resources and Environmental Control, State of Delaware, for permission for my continuing scientific investigations of the herpetofauna of Delaware. Specimens have been deposited in the Carnegie Museum of Natural History (CM). The numbers in brackets for a given species enumerate localities.

Regina septemvittata (Queen snake) - Conant (1945, and pers. comm., 1973) recorded it from Newark, from 3.2 km S Newark, and from Wilmington, all New Castle County. One adult (CM 108981) was found sunning on grasses in a small, open and well-lighted marsh, E side Rt. 13, 1.7 km S Chesapeake and Delaware Canal, New Castle County, 6 May 1972, by Grace M. Tilger and myself. It has been reported on by Arndt (1976). This specimen is notable as it is apparently still the southernmost record for the state. Another snake with it but which escaped was probably also of this species.

Storeria o. occipitomaculata (Northern red-bellied snake) - One adult male (CM 108982) was taken in a trash pile in an open, brushy area surrounded by mature mixed forest, 11.2 km E Laurel, Sussex County, 4 August 1984, by Joan A. Pienta, M. J. Geiger, R. M. Pusey, and myself. It is a male with a brick-red dorsum, of 148 mm snout-vent length and 195 mm total length. A dead-on-road (DOR) adult with a gray dorsum was found in Trap Pond State Park, Sussex County, on 15 August 1981 by J. F. White; it was not saved or photographed. Conant (1975) recorded it from Delaware on the basis of Delmarva Peninsula specimens taken just west and south of this state (R. Conant, pers. comm., 1985).

Virginia v. valeriae (Eastern earth snake) - Conant (1958) recorded one specimen from (1) Ellendale, Sussex County, taken 29 April 1946, and four specimens from (2) about 3.2 km SE Glasgow, New Castle County, taken 17 April 1953. To these can be added four specimens from three additional localities. (3) One adult (CM 108983) was found DOR in an area of deciduous forest, 3.2 km S Townsend, New Castle County, 28 September 1973, by R. Lynn Johnson and myself. (4) One adult (CM 108984) was found alive during excavations in a house basement in Guyencourt, MW Brandywine Creek State Park, New Castle County, 15 January 1974, by John D. Kern. (5) Two adults (CM 108985, 108986) were found under roofing shingles in a trash pile in a clearing surrounded by mature mixed forest, 8 km NE Seaford, Sussex County, 11 August 1984, by Damon M. Smith and myself.

Elaphe g. guttata (Corn snake) - It has to date been reported only from Sussex County, from (1) an open, cultivated area near Seaford by Conant (1945) and (2) from near Cape Henlopen State Park by Hillis (1974) and from Lewes by Arndt (1976). The last record is now CM 108987.

Further work has yielded additional specimens, all from Sussex County. As many as seven adults were observed in one day at locality (2) in eastern Lewes, and at the nearby (and habitat-continuous) Cape Henlopen State Park.

All were found under concrete, railroad ties and tin sheets on at least 13 dates from 20 May 1976 to 10 May 1984 by M. J. Geiger, Jim Meril, or myself; many are documented in photographs. (3) One adult (CM 108988) was found next to a farm building, 6.1 km E Laurel, 17 August 1962, and was killed by being doused with gasoline. According to R. M. Pusey, who obtained the specimen, the capture spot was then a homestead surrounded by cultivated fields; the site is unchanged to date (1984). (4) One hatchling or one adult was found on, or under shelter adjacent to, a highway at several points from 2.9 to 3.2 km SW Blades (S of Seaford) on each of six dates from 9 October 1979 to 26 July 1984 by M. J. Geiger; they are documented in photographs. (5) One hatchling was found DOR 0.5 km SW Blades on or about 15 October 1983 by M. J. Geiger; it is not documented. Another DOR hatchling (CM 108989) was found 0.6 km SW Blades, 9 October 1984, by M. J. Geiger. (6) One DOR adult was found 4.8 km SW Seaford, 4 June 1984, by M. J. Geiger; it is documented in photographs. Although close to localities 4 and 5, locality 6 is separated from them by the Nanticoke River. These data suggest that there are at least three populations of the corn snake in the area southwest of Seaford.

Most of the above specimens are from dry, sandy pine barren-like areas, although two (from localities 3 and 6) are from the cultivated field and house yard habitats now common in the region. Additional work will probably reveal the corn snake to be even more widespread throughout at least southern Sussex County.

Ashton (1976) listed the corn snake in Delaware as rare and suffering from commercial exploitation. The above records show that it is more widespread and common than previously known. The degree of commercial exploitation, if any, is not known. In Delaware it probably suffers most from destruction of its preferred habitat of woods and brush in dry and sandy areas.

Lampropeltis g. getulus (Eastern kingsnake) - Conant (1945) recorded it from numerous counties on the Delmarva Peninsula, but not from Kent and New Castle counties, Delaware, while Conant (1975) records it from all but northern-most Delmarva. Arndt (1976) recorded it from throughout Delaware, north to the Chesapeake and Delaware Canal, New Castle County, on the basis of an adult (CM 108990) found DOR 1.6 km SE Chesapeake City, Cecil County, Maryland, and 1.6 km W Delaware state line, 19 June 1974, by William H. Bason. Harris (1975) also recorded it from Cecil County, Maryland, and from northeastern Kent County, Delaware.

This species is here recorded from New Castle County, with an additional record from Kent County, Delaware. (1) One adult (CM 108991) was found alive on a highway (AOR) bordered on one side by a large field prepared for planting and by a large uncultivated meadow on the other, 2.4 km SE Odessa, New Castle County, 10 May 1973, by Fred C. Rohde. (2) One DOR adult (CM 108992) was found near a stream in an area of mature deciduous forest, 1.6 km S Townsend, New Castle County, 26 August 1973, by F. C. Rohde and myself. (3) One adult was taken DOR in an area of open, cultivated fields at the entrance to Killen Pond State Park, some 19 km S Dover, Kent County, 11 June 1973, by F. C. Rohde, Johnson C. S. Wang, and myself; it was not saved.

Cemophora coccinea copei (Northern scarlet snake) - A specimen taken at Buzzard's Point, southern shore of Trap Pond, Trap Pond State Park, Sussex County, is the first recorded specimen for the state and only the second documented specimen for the Delmarva Peninsula. The latter was taken April 1923 near Salisbury, Wicomico County, Maryland (Conant, 1958).

The Delaware specimen (CM 108993) was found at dusk while active above ground, 21 June 1963, by a Boy Scout, and subsequently obtained by R. M. Pusey who preserved it in formalin on 8 July 1963 (R. M. Pusey records and pers. comm., 1985). He later gave it to M. J. Geiger, who then presented it to me. R. Conant, through the courtesy of R. M. Pusey, has long had this specimen noted in his records, but not published specifically on it. The adult specimen is 46.7 cm snout-vent length and 53.5 cm total length, and has 20 dorsal red blotches; its sex has not been determined. The capture spot is on a small sandy peninsula free (in 1984) of undergrowth and used as a picnic area. Vegetation is mature mixed forest of loblolly pine, *Pinus taeda*; Virginia pine, *P. virginiana*; sassafras, *Sassafras albidum*; sweet gum, *Liquidambar styraciflua*; swamp maple, *Acer rubrum*; American holly, *Ilex opaca*; dogwood, *Cornus florida*; black oak, *Quercus velutina*; white oak, *Q. alba*; green ash, *Fraxinus pennsylvanica*; black tupelo, *Nyssa sylvatica*; cypress, *Taxodium distichum*; and American beech, *Fagus grandifolia*. Blueberry, *Vaccinium* sp., and cat-brier, *Smilax* sp., are common on the peninsula edge.

Agkistrodon contortrix mokasen (Northern copperhead) - Several additional specimens and new localities can be added to the two reported localities from Sussex County, from (1) 8.0 km W Millsboro (Conant, 1945) and (2) NW edge of Trap Pond State Park (Arndt, 1976), and to the only reported locality for it from New Castle County, from (3) Alapocas Woods, N edge of Wilmington (Conant, 1945).

Sussex County: There are additional specimens from locality (2). One adult (CM 108994) was killed near the northwest corner of Trap Pond State Park, summer 1972, after a child stepped on the snake by a woodpile behind a small grocery store and about 250 m from the two adults (now CM 108995, 108996) reported on by Arndt (1976). The child was not bitten. Specimen and data from C. E. Mohr. (Seven young born to CM 108996 on the night of 10-11 September 1972 are now CM 108997-109003). Another adult (CM 109004) was taken in Trap Pond State Park on 19 or 20 July 1973 after reportedly biting a dog and then the dog's owner. Both survived and evidently with little adverse effect to the human (pers. comm., R. R. Roth and E. P. Catts, 1984). This snake was recently obtained from R. R. Roth. One juvenile was seen AOR at night, S edge Trap Pond State Park, 7 August 1978, by M. J. Geiger; it was not preserved or photographed. A number of specimens were seen in this Park in the summer of 1983 (pers. comm., D. J. Cretty, 1984). (4) One adult (CM 109005) recently obtained from R. R. Roth was found DOR at Laurel by J. O'Day on 11 September 1959. (5) One adult (CM 109006) was killed when discovered next to a chicken coop, Whaley's Crossroad, 11.3 km E Laurel, early 1960's. The specimen and data are from R. M. Pusey (pers. comm., 1984), who also provided the data on the following two specimens. (6) One adult (CM 109007) was shot in a house kitchen, Lowes Crossroads,

14.5 km E Laurel, early 1960's. (7) One adult (CM 109008) was killed next to a farm building, Puseys Crossroad, 12.9 km E Laurel, early 1960's. (8) One AOR adult was found at night near the downstream end of Trussum Pond, 6.4 km SE Laurel, 16 September 1978, by M. J. Geiger; it was photographed and released. (9) One DOR juvenile was found at Hitchens Crossroad, 9.7 km ENE Laurel, on or about 20 September 1978. This undocumented sight record by David Jackson was made available through M. J. Geiger. (10) One adult was found DOR, 11.7 km E Laurel, and a second adult was found alive on a road, about 15.3 km E Laurel, both late in September 1983, by Grady E. Griggs, Jr. (J. F. White, pers. comm., 1985, and see photograph of snakes in Anonymous, 1983). The specimens were found during daylight, one or two days apart, and were evidently not preserved (Frederick T. Mott, Kent County, Delaware, District Conservationist, pers. comm., 1985). (11) One specimen was found in a sandy area of loblolly pine, American holly and chestnut oak, *Quercus prinus*, crossing a sand road near Camp Barnes, Assawoman Wildlife Area, on a sunny afternoon in 1956, probably in July (E. Paul Catts, pers. comm., 1984, 1985). Catts informed me that the snake was deposited at the Academy of Natural Sciences in Philadelphia, but neither the specimen nor an entry for it in the Academy herpetology catalog could be located.

Visits with R. M. Pusey and M. J. Geiger in 1984 to the capture/observation spots for most of the above specimens indicate that they were taken/observed in or adjacent to mature mixed forest dominated by loblolly pine, sweet gum, wild cherry, *Prunus* sp.; red oak, *Quercus rubrum*; white oak, swamp maple and American holly.

New Castle County: (3) One adult (CM 109009) was found DOR in a hilly, rocky area with brush and mature deciduous forest on Wilmington Friends School property, edge of Alapocas Woods, 15 June 1982 (specimen and data from T. C. Putney, pers. comm., 1984). A live copperhead was seen there in October 1983, and there were three additional sightings in spring 1984 (pers. comm., M. M. Harrell, 1984). The copperhead thus still persists in this wild enclave in an otherwise heavily suburban/urban area. (12) One adult was found in or near Brandywine Creek State Park, about 6.4 km N Wilmington, on or about 20 September 1977. It reportedly bit a human, who was treated in a hospital emergency room. The snake apparently was not saved. Data from R. R. Roth, pers. comm., 1984. This park is in a rural area now rapidly becoming suburban.

The copperhead in Delaware is listed by Ashton (1976) as rare and suffering from habitat destruction. This evaluation of its status appears to be accurate.

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NEW DISTRIBUTION RECORDS FOR MARYLAND
REPTILES AND AMPHIBIANS

The following records of Maryland amphibians and reptiles provide some new localities not available and hence not listed by Harris (1975) including several new county records. Thanks are due to Robert Miller and Michael Geiger for providing information on several specimens.

Notophthalmus viridescens. Harris (1975) stated that "Present records indicated its absence from the lower Eastern Shore of Maryland", although acknowledging a record by Conant (1945) from Northhampton County, Virginia. Recently, Miller (1984) noted a specimen from near Lakesville, Dorchester County. During late April 1979 my son Charles Grogan collected two efts from a small woodland pond N of Levin Dashiell Rd. approximately 2 km W of Salisbury, Wicomico County. Both specimens were released since I failed to realize at the time that this species was unknown from the county.

Cnemidophorus sexlineatus. Harris (1975) notes that this species is a Coastal Plain form in Maryland but cites records for Frederick and Allegheny Counties as examples of this species expanding its distribution via the Potomac River. On 18 June 1976 I observed a large adult of this species foraging in the floodplain of the Potomac River 1 km SW of Cabin John, Montgomery County. This locality is situated approximately midway between Lock 12 on the C&O Canal and the southern tip of Plummer's Island and is on the Eastern Piedmont. This specimen was observed for several minutes as it searched for insects but could not be captured, and represents the first record of this species for Montgomery County.

Eumeces laticeps. Harris (1975) notes a single record of this species for each of the four counties of the lower Eastern Shore. A large adult male of this species was taken during August 1984 from Shad Landing State Park, Worcester County by a visitor to the park. It had a snout-vent length of 115 mm and total length of 281 mm and was kept by the park rangers for a few weeks in captivity and later released.

Lampropeltis triangulum. A specimen was taken by Carlton Windsor, Jr. on 12 September 1983 as it was crawling on a pile of maple logs within a sawmill site on Peggy Neck Rd. 2.5 km E of Loretto (7 km NNE Princess Anne), Somerset County. This specimen is catalogued TSU 6335 in the Towson State University herpetological collection and represents a new county record for this species for Somerset County. It is a juvenile female with a snout-vent length of 284 mm and total length of 331 mm and is a typical example of the coastal plain milksnake, or intergrade *L. t. triangulum* X *elapsoides* as described by Williams (1978) and Conant (1975).

Cemophora coccinea. A large specimen of this species (ca. 530 mm) was taken during June 1975 by Mark Mengele, a park ranger at Shad Landing State Park, Worcester County as it was crossing a road in the park. This

specimen was examined by Michael Geiger who retains a photograph of it, however the snake was apparently later released. This is the first record of this species for Worcester County.

Nerodia erythrogaster. On 6 June 1983 I discovered a DOR specimen on New Bridge Road at the Chicamacomico River 5 km W of Vienna, Dorchester County. This specimen is catalogued TSU 6334 in the Towson State University herpetological collection. This large female with a snout-vent length of 984 mm and total length of 1225 mm is apparently the largest individual from Maryland. Harris (1975) lists four records of this snake from Dorchester County including one from near Bucktown. Another specimen catalogued NHSM/HSB 1126 in the Natural History Society of Maryland was taken approximately 1 km N of Bucktown, 23 September 1975 by R. Czarnowsky, B. Biggs and R. Miller. Robert S. Simmons in July 1975 saw two specimens and collected one from under a piece of tin next to a ditch along side Md. Rt. 331, 9 miles SW Vienna, Dorchester County (Harris, 1975). These records indicate that this species is rather commonly distributed in the southern half of Dorchester County although it is rarely seen or collected.

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BODY LENGTH OF MALE *CRYPTOBRANCHUS ALLEGANIENSIS*
AT SEXUAL MATURITY

The size of male *Cryptobranchus alleganiensis* at sexual maturity has not been accurately documented. Nickerson and Mays (1972) indicated it to be approximately 340 mm (probably total) length but expressed a degree of uncertainty.

As in other urodeles, the testes of *Cryptobranchus* undergo an annual maturational cycle (Burger, 1937; Humphrey, 1921). According to Humphrey (1921), primary spermatogonia are surrounded by epithelial cells comparable in function to mammalian Sertoli cells. Division of spermatogonia and epithelial cells initiates formation of lobular lumina, after which the full sequence of germinal cell maturation proceeds as a cephalocaudal wave. This progression is rapid and difficult to observe (Humphrey, 1921) but McGregor (1899) considered sperm maturation in *Cryptobranchus* to occur immediately prior to fertilization without prolonged storage in the testes. Maturation divisions occur between June and August (Humphrey, 1921) and spawning is in October (Ratcliff, 1965).

We have determined by light and scanning electron microscopy the body size at which male *Cryptobranchus alleganiensis* become gametogenic.

Thirty-one *Cryptobranchus alleganiensis* were hand-caught in the Allegheny River 3 km southwest of Tionesta, Pennsylvania, on May 29 (7 animals) and on 31 August, 1980 (24 animals). They were killed with ether and measured (standard snout-vent length) dead. Cranial, middle and caudal portions of both testes of each animal were fixed in Karnovsky's (1961) fixative or in alcohol-formol-acetic acid (AFA) for electron and light microscopy, respectively. The presence of sperm was also confirmed by microscopic examination of fresh testicular exudate of the larger salamanders. Fixed exudate of mature animals was filtered through Whatmans No. 1 paper which was then trimmed, folded, and stapled. The resulting packet was dehydrated through a series of ethyl alcohols and critical-point dried. A small piece of double-stick tape was used to transfer clumps of sperm to the specimen stub. Sperm were coated with gold approximately 45 nm thick and observed with a Coates and Welter (Cwiskscan 106A) field emission scanning electron microscope. AFA-fixed samples were dehydrated through a series of ethanols and embedded in Paraplast. Sections 6 and 8 μ thick were stained with hematoxylin and fast green.

The smallest specimen with testicular sperm was 200 mm snout-vent length (S-V-L). All longer animals were also spermatogenic (Figure 1). The testes of a 187 mm S-V-L salamander in August contained spermatids and some secondary spermatocytes. The next four smaller animals with S-V-L of 184-, 178-, 166- and 154 mm were collected in May. Since *Cryptobranchus* testes being their recrudescence in June (Humphrey, 1921) no sperm were expected. However, spermatids were present in the 184- and 166 mm animals. Secondary

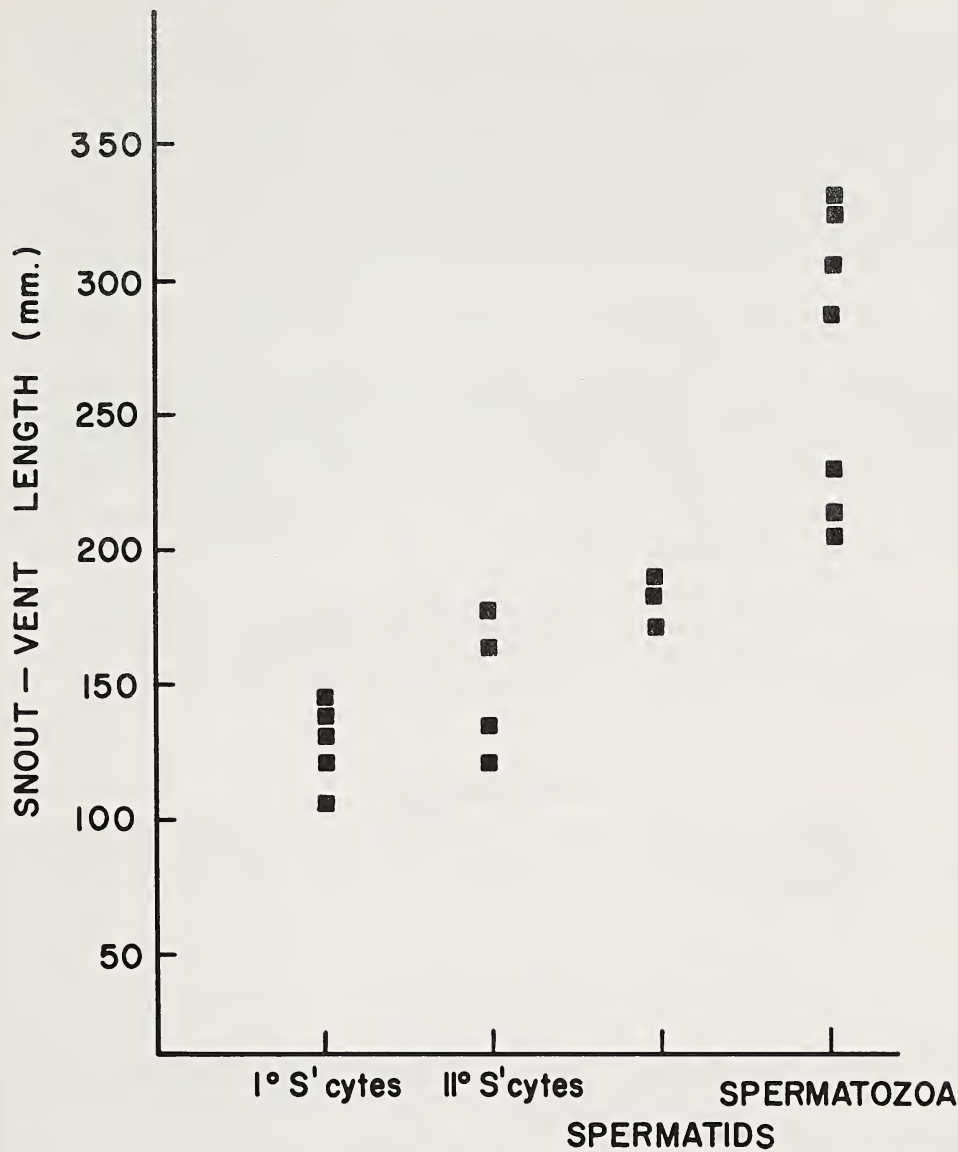


Figure 1. Correlation of most-differentiated germinal epithelium type with snout-vent length of 19 *Cryptobranchus*. All longer animals examined bore spermatozoa.

spermatocytes characterized the germinal epithelium of the smaller animals. Since gametes in immature *Plethodon* develop until the spermatocyte stage before degenerating (Burger, 1937) and during May immature *Necturus* testicular lobules consist of spermatogonia with no indication of spermatocytes (Humphrey, 1921) it is possible that the 178 mm animal would have shortly experienced gametogenesis. His testes were more distended than those of smaller, immature animals. Similarly, the presence of spermatids in the May animals measuring 184 mm and 166 mm S-V-L also suggest sexual maturity with the possibility of spermiogenesis during the current summer.

The presence of spermatids in two animals collected in May advance the date of gametogenesis relative to that (June) cited by Humphrey (1921). Spermatozoa in the seven animals collected in August and spermatids in another smaller animal (Figure 1) indicate spermiogenesis and a breeding season beginning in mid to late August since the duration of testicular sperm storage is minimal (McGregor, 1899). Two immature salamanders taken in August contained primary and secondary spermatocytes. Testes of the other animals (137-, 136-, 132-, 122-, and 102 mm S-V-L) had no germ cells advanced beyond primary spermatocyte level. Their testicular lobules were fewer in number and the testis was thread-like.

These observations show that male *Cryptobranchus* are gametogenic at 166 mm S-V-L. From comparable observations of gametogenesis in other salamanders, it is assumed but not known that *Cryptobranchus* of this size could become active breeders in the streams from which they were taken.

Acknowledgements

We thank K. G. Walker and A. H. Wikramanayake for field assistance, G. V. Callard for commenting on testicular histology, and Claudia Errera for typing the manuscript.

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—Eric D. Wikramanayake and G. L. Dryden, *Department of Wildlife and Fisheries Biology, University of California, Davis, California 95616, and Biology Department, Slippery Rock University, Slippery Rock, Pennsylvania 16057.*

Received: 13 March 1985
Accepted: 20 April 1985

NEWS AND NOTES:

BOOK REVIEW:

A FIELD GUIDE TO WESTERN REPTILES AND AMPHIBIANS. Second edition, revised. By Robert C. Stebbins. Houghton Mifflin Co., 2 Park St., Boston, MA 02108. xvi, 336 pp., 40 figs., 48 pls. (35 col.), 200 maps. 1985. \$12.95 paper, \$17.95 cloth.

The eagerly anticipated second edition of this classic, first appearing 20 years ago (1966), is at last at hand, and a noble successor it is, with thoroughly up-dated information, an expanded coverage that includes the herpetofauna not only of the states of New Mexico, Colorado, Wyoming, Montana, Saskatchewan and Northwest Territory and all adjacent lands to the west (as before), but also mainland (not insular) Baja California, with numerous new illustrations and maps.

Indeed, all maps have been redrawn, 188 taking the place of 190 in the first edition, but one being added to depict vegetational zones of Baja California, and eleven to account for species (called "endemics") limited, within the scope of this work, to Baja California. Most of the plates are the same as in the first edition (although the color plate of skinks is not reproduced as well), but 35 are in color (vs. 24 in the first edition), for a total of 48 (vs. 39). A total of 244 species is treated (vs. 207), only 17 of which are Baja California "endemics." Twenty "endemic" subspecies, however, of species occurring in the United States, had to be included because of the coverage of Baja California. With 260 subspecies accounted for, 504 species-group taxa are embraced. The figures are the same as before, except for the addition of one figure of *Tantilla hemipenes*.

The new plates include eleven in color: two of *Batrachoseps*; one of leopard frogs; two of *Holbrookia*, *Cophosaurus*, *Callisaurus* and *Uma* (replacing one black and white plate); one of *Gambelia*, *Crotaphytus* and *Dipsosaurus* (replacing a B-W plate); three of *Cnemidophorus* (replacing one B-W plate); and two of Baja California "endemics." In addition, four color figures of geckos are added to a former plate, one new B-W plate of Baja California "endemics" is included, and the original six B-W figures of *Tantilla* are replaced by five (one eliminated, two redrawn). Thus there is an astounding total of 601 separate illustrations, 245 of them in color. Only 12 species are not illustrated: *Dicamptodon copei*, *Scaphiopus multiplicatus*, *Bufo exsul*, *B. nelsoni*, *Rana clamitans*, *R. onca*, *Pseudemys concinna*, *Eretmochelys imbricata*, *Trionyx muticus*, *Coleonyx brevis*, *Crotaphytus insularis*, and *Gerrhonotus paucicarinatus*.

Only one typographical error was noted, *Coleonyx swaitaki* replacing *C. switaki*. However, the customary error of spelling of *Lampropeltis getulus nigrilus* (instead of the correct *L. g. nigrila*, required in the feminine gender to agree with the feminine generic name, since the subspecific name is clearly an adjective, hence must modify *Lampropeltis*; *getulus* appears to be a

barbarism, and was so considered by Barbour, pers. comm.) was perpetuated. On the other hand, the grammatically incorrect *Sceloporus graciosus arenicolous* was properly rendered as *S. g. arenicolus*.

A conservative stand was adopted in most instances of taxonomic controversy, as indeed is desirable in any work such as this that inevitably serves as a standard for many years. However, fuel was added to the recurrent rumors of a species of *Bipes* occurring in southern Arizona (p. 243), and a few common names were adopted that do not conform with the conventional standard. Conservatism is especially welcome in the case of (1) *Anniella*, for which the name *A. pulchra* is retained in its long-familiar sense, rather than being transferred to a different species as proposed recently (an appeal to the International Commission on Zoological Nomenclature to preserve the earlier status quo is in process); (2) *Gerrhonotus* s.l., since the application of that name in its broad sense (rather than in the narrow sense, limited to *G. liocephalus*, with allocation of other species to *Elgaria* and *Barisia*) is required by discovery that *G. parvus* is oviparous, hence like *G. liocephalus*, although its scutellation agrees with *Barisia*, all species of which are viviparous, leaving no single criterion for separation of *Gerrhonotus* s.s. and *Barisia* (*Elgaria* likewise falls on egalitarian grounds); (3) a monotypic *Phrynosoma douglassii*, in which subspecific distinctions have long been tacitly (occasionally explicitly) recognized as objectively indefensible even if subjectively accepted; (4) a monotypic *Hyla regilla*, in admission that techniques do not yet exist satisfactorily to delimit the several proposed subspecies of it; and (5) preservation of the legally correct (however exasperating) -ii genitive ending for species-group names thus originally proposed.

Conservatism is less overwhelmingly justified in (1) rejection of specific distinction of some populations commonly allocated as subspecies of *Sceloporus magister* despite karyological evidence (admittedly not fully documented) to the contrary; (2) rejection of specific status for *Salvadora deserticola* (again not fully documented); (3) rejection of polytypy in *Hypsiglena torquata*; and (4) rejection of *Spea* as a valid genus, strictly in conformance with almost universal custom, despite abundant evidence (admittedly not vigorously presented) of distinction from *Scaphiopus*.

Other taxa more clearly justified in their elimination in the interest of conservatism are *Hyla eximia wrightorum* and *Tropidoclonion lineatum mertensi*, the validity of each of which will undoubtedly be reestablished with fully synoptic study.

On the other hand, the recent careful studies of the difficult genera *Batrachoseps* and *Rana* were accepted in full, even to inclusion of as yet unnamed taxa. It is heartening to observe retention of the well-established subspecies *Sceloporus graciosus vandenburgianus* despite its neglect in a recent review.

Indeed, the one omission most regretted is a more frequent notice of uncertain or debatable matters (although occasionally briefly inserted, e.g., in the accounts for *Sceloporus magister* and *Salvadora hexalepis*).

Suggestions for future study are always stimulating, although of course ephemeral in pertinence, as knowledge expands without revision of its summary. An excellent new cautionary word is inserted in the introduction of (p. 8), about the potentially excessive weight of the printed word, but consistent attention to likely fallibilities and gaps in knowledge would be useful. It might also be too space-consuming.

Only in the context of some of the Baja California endemics were lapses in consistency of treatment detected. - *Crotalus enyo* and *Nerodia valida*, for example, are implied by mistake to be monotypic, whereas their subspecies are well established, and the range of the latter outside of Baja California is not shown although its map includes at least part of its territory. Likewise, the map for *Ctenosaura hemilopha* shows the range for the whole species in the shading indicative of the nominate subspecies, whose range is correctly shown on mainland Baja California.

For the benefit of those unfamiliar with the first edition, it should be noted that an excellent introduction of 23 pages covers a broad range of general information; that well-illustrated keys are provided for identification of species on the basis of post-embryonic (or post-larval) material (to which the main body of the text pertains), as well as for amphibian eggs and larvae (in an appendix of 26 pp., with brief descriptions as well as the illustrated keys); that the maps are collected at the end of the book; that there is a 5-p. glossary and four pages of references; that all plates are collected near the middle of the book; that the 40 figures are scattered through the text; and that there is an excellent, 14-p. index.

The introduction is much the same as in the first edition, judiciously augmented here and there, although the discussion of field study techniques, including marking, is greatly curtailed in the second edition, and the supportive figure omitted, substituting the recommendation that professional guidance be sought for such studies. No attempt is made, wisely, to summarize knowledge of herpetological natural history; instead the introduction limits itself to a very personal field vade mecum, and to use and rationale of the book. Topics covered are, seriatim, Area Covered, How to use this Book, Illustrations (briefly stating the author's bias as a highly talented and experienced artist), Size, Color, Young, Sex Differences (reviewed in some detail for salamanders, anurans, turtles, lizards and snakes), Voice, Time of Activity and Breeding, Habits, Food, Subspecies, Biochemical Taxonomy, Distribution Maps, Use of Names (he rejects eponyms), Metric System (used throughout, with conversion to the English system given parenthetically), Making Captures (including use of a snake stick, noosing, night driving, triangulation, eyeshines, tracking and containers for specimens), Caring for Captives (including temporary quarters, cages, substrate, temperature, feeding, rearing amphibian larvae, rearing reptile eggs, choice of captives), and Field Study and Protection.

This field guide is unique in many ways; it has no competitor in coverage of amphibians and reptiles of western North America or Baja California; and it is the only herpetological guide illustrated by the author, who is not only a superbly skilled artist but a lifetime authority on

the herpetofauna of the area covered. The second edition is a monumental achievement in both artistry and scientific acumen in the context of use by both novice and expert. Its serviceability will surely at least equal the time-span of the first edition: a sure, long-term investment for every buyer.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado 334, Boulder, Colorado 80309.*

NEWS AND NOTES:

EARTHWATCH

BULLETIN

Contact: Blue Magruder
617-489-3030

IONIAN SEA TURTLES FIGHTING FOR A BEACH-HEAD

By Mark Cherrington

EARTHWATCH News Service

When a female loggerhead sea turtle crawls ashore to lay eggs on midnight beaches, she cries continuously. The tears are in fact a means of removing the salt that accumulates in her ocean environment, but they might as well be shed for the fate of her kind. Sea turtles of all species live in a precarious balance with mankind. From the enormous leatherback to the relatively tiny Ridley's, these antediluvian reptiles face habitat loss, competition, and persecution around the world.

Unlike most of its cousins, which are endangered, the loggerhead is listed only as threatened. That comparative security may be due partly to the loggerhead's more flexible feeding habits. Loggerheads sometimes lunch on lobsters, crabs, and other crustaceans near shore, but are also perfectly happy ingesting jellyfish far out at sea.

During the 170 million years they've been swimming the world's seas, loggerheads have outlived most of their prehistoric predators and have seen oceans come and go. Their thick shells can deflect even shark bites. In fact, turtles that have been bitten sometimes attack sharks, killing them by ripping out their gills. They even manage to survive colonies of barnacles that sometimes grow in their throats. But nothing in the loggerhead's long history could have prepared it for pound cake and tourists.

The pound cake threat came about because loggerhead egg whites don't coagulate. Pound cake made with them taste better and last longer than those made with chicken eggs. In the southern U.S., an entire industry grew around loggerheads' eggs; egg trucks from various bakeries decimated the turtles' nesting beaches until the animals came under the protection of the Endangered Species Act in 1972. Today poachers still take eggs for food both in the U.S.

-more-

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NEWS AND NOTES:

Loggerheads 2/2/2

and in the Mediterranean, but the problem has lessened considerably. The tourists, however, may prove a thornier problem.

Like all sea turtles, loggerheads nest on secluded beaches, a preference that increasingly puts them in conflict with seclusion-hungry vacationers. The tourists are not a direct threat to the turtles, but their presence makes nesting much more difficult. Nesting females are skittish emerging from the sea at night; lovers strolling the beach and the lights and commotion of resorts often drive the turtles back into the water where they abort their eggs. The problems don't end, though, even for those eggs that are laid. When newborn turtles hatch, they find their way to the sea by cuing off lighter sky over the water. Unfortunately, resort lights and street lights often lure hatchlings in the wrong direction where they become vulnerable to predators and the deadly heat of daylight.

In the Mediterranean, loggerheads' problems are compounded by an enormous increase in the number of tourists and by ever-growing pollution. There may be hope, however. Marine biologist James Sutherland of Sussex University in England has found a relatively large and hitherto unknown nesting colony on the island of Zakynthos, Greece. In 1983, his preliminary census recorded some 2,500 nests laid by 820 turtles, making it the largest colony in the Mediterranean. This summer, he plans to return to the Ionian Islands to thoroughly document the turtles' behavior and to help assess their needs so that protective measures can be taken by the Greek government.

His current work is being underwritten by EARTHWATCH, the non-profit organization that recruits paying volunteers to help share the cost and the work of field research. Dr. Sutherland still needs volunteers for a series of two-week teams that run from June 2 through October 6. Team members will assist in every phase of the work, from patrolling the beaches to measuring the turtles, to counting and measuring the turtles, to counting and measuring the eggs, to recording weather conditions. For more information, call Nancy Gunnlaugsson at 617-489-3030, or write Loggerhead Turtles, EARTHWATCH, 10 Juniper Road, Box 127N, Belmont, Massachusetts 02178.

5/10/85

#

NEWS AND NOTES:

ANNOUNCEMENT
FOR IMMEDIATE RELEASE
YOU ARE INVITED ON A ZOO RESEARCH EXPEDITION

The Zoo and Aquarium Travel Association (ZATA) has invited its member zoos and aquariums to offer a unique travel program to its members. The program will be to San Esteban Island in the Sea of Cortez off the western coast of Mexico. There, members of the Arizona-Sonora Desert Museum along with the research team made up of zoo society travelers from ZATA zoos and aquariums will observe and capture the endangered, giant chuckwalla that live on the island. This study is being conducted to study behavior, and other aspects of the lizard's biology so that captive colonies of these animals can be maintained properly. This impressive lizard is found nowhere else in the world.

Come and join one of the 11 day expeditions if you would like to do more than just visit a place and would like to get involved with a real zoo research program. The tax deductible price for this expedition is \$1595, all inclusive, from Tucson. The expedition departure dates are April 17, 1985 May 31, 1985 October (date to be determined), January 10, 1986. From Tucson where there will be a training program and tour of the famous Arizona-Sonora Desert Museum, we travel by van to Kino Bay, Mexico. There we board the comfortable 120' Baja Explorador, which will provide our accommodations during our stay. A member of the ZATA staff will accompany the expedition and care for the needs of the staff and organize the program.

Side trips are planned for surrounding islands and there will be plenty of time for snorkeling, fishing and wildlife observation. Contact ZATA, 1776 Independence Court, Birmingham, AL 35216 for more information, 1-800-633-4734.

NEWS AND NOTES:

RESEARCH EXPEDITION APPLICATION
PAGE TWO

ARIZONA-SONORA DESERT MUSEUM
RESEARCH EXPEDITION APPLICATION

Please complete this application and return it along with your reservation certificate. Please note that ZATA or the Arizona Sonora Desert Museum retain the right to reject prospective participants in the Desert Watch Research Expedition. Applications will be evaluated to see that the applicant's health, background and interests are compatible to the research programs needs and goals, the environment, and living conditions at the research site. If you have questions, please do not hesitate to call (1-800-633-4734).

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NEWS AND NOTES:

SSAR REGIONAL HERPETOLOGICAL SOCIETY
LIAISON COMMITTEE

The SSAR created a Liaison Committee in 1977 to establish a closer relationship with Regional Herpetological Societies. Communication has been established, but obtaining responses from some societies has been difficult.

In order to keep herpetologists informed about the activities and upcoming events of your society, we are asking each Regional Society to send current information to the Liaison Committee and to put the Liaison Committee on your mailing list.

We will also be updating our directory and would like to include your group. Please send the following information to the Liaison Committee as soon as possible.

Group Name
Contact Person
Mailing Address
Publications

Any information to be published in Herpetological Review has to be received at least 2 months before publication date. For example, anything to be published in the June 1985 issue has to be received by March 31, September 1985 by June 30, and December by September 30.

Any suggestions concerning the work of the Committee and topics of future conferences would be greatly appreciated.

Terry Hibbitts, Chair
SSAR Regional Herpetological Society Liaison
309 South 4th Street
Wylie, Texas 75098

NEWS AND NOTES:

SSAR REGIONAL HERPETOLOGICAL SOCIETY
9TH ANNUAL CONFERENCE, TAMPA, FLORIDA

The Ninth Annual Regional Herpetological Conference sponsored by the SSAR will be held August 7 during the 1985 joint meeting of the SSAR and HL at the University of South Florida in Tampa. The title of the conference is "Methods to Enhance the Regional Herpetological Society". Tentative topics are: Improving Newsletters and Journals, Personal Relations, Preparing Slide Programs, Auctions, Mall Shows, Field Trips, Membership Involvement, and Annual Conferences.

There will also be tables available for Regional Herpetological Societies to distribute information about their society. Each society should provide approximately 100 brochures about their society to be distributed at the conference. The brochure should include purpose, history, activities, membership categories, dues, and contact person for additional information. If you can not attend the conference, please forward brochures to me and I will be sure they are displayed.

Please encourage the members of your society to attend the afternoon conference as well as the entire SSAR/HL meeting August 4-9. Help us make the conference a success.

Additional information about this meeting will be published in the next issue of HR. Inquiries may be directed to:

Terry Hibbitts, Chair
SSAR Regional Society Liaison
309 South 4th Street
Wylie, Texas 75098

NEWS AND NOTES:

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Dinosaurs. The word conjures up, for most of us, visions of enormous prehistoric monsters, jaws gnashing with razor sharp teeth, claws poised to rip their helpless prey to bloodied shreds. We imagine massive, awkward, stupid, vicious beasts -- as we view their fantastic skeletons in the museum, we sigh with relief that only their bones remain.

However -- the real dinosaurs and their 140 million year history are far different from these popular conceptions -- far more interesting and complex too. Did you know for instance that:

- * many scientists now believe dinosaurs were warm-blooded?
- * they are the only reptiles that ever succeeded in standing on their own two feet?
- * they were probably not slow and clumsy, but usually fast and active?
- * they did not have small brains?

People seem to have an insatiable interest in dinosaurs. Witness how they have captured our imagination in fiction, science fiction, cartoons and cinema. The Dinosaur Gallery is invariably the major attraction of any natural history museum fortunate enough to have one. When a new dinosaur site was discovered near Artesia, Colorado, the town quickly renamed itself Dinosaur and now has streets with names like Brontosaurus Boulevard, Stegosaurus Freeway and Triceratops Terrace.

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This is a book to satisfy and spark our curiosity about these wondrous creatures. It covers every aspect of dinosaur lore and science, from how dinosaurs were fossilized to their origin, discovery and death, with chapters describing all the different sorts of dinosaurs. Here we see how the study of dinosaurs is not dead; how, in fact, there are many questions that continue to be hotly debated by scientists around the globe.

But the thorough, easy-to-read and captivating text is only part of this definitive work's appeal. There is also an outstanding and vivid series of watercolor plates that authentically recreate the world of the dinosaur -- down to the very details of landscape and vegetation. And all the known facts and theories are explained with the aid of superb black-and-white restorations, maps, charts and photographs.

Anyone who already has an interest in these prehistoric creatures is sure to enjoy and be enriched by A NEW LOOK AT DINOSAURS; anyone new to the subject is sure to quickly become an avid and fascinated dinosaur fan.

ALAN CHARIG is curator of Fossil Amphibians, Reptiles and Birds at the British Museum (Natural History).

A NEW LOOK AT DINOSAURS
By Alan Charig
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Publication date: May 7, 1985

NEW BOOK IS SPECTACULAR WINDOW ON THE WORLD OF HOW ANIMALS SEE

How do owls see in the dark? Can fish see beyond the water's edge? Does a flower look the same to a bee as it does to us? For ages, man has wondered how other creatures perceive the world.

Now, readers get a fascinating close-up on the astonishing perceptions of the animal kingdom in a new book, HOW ANIMALS SEE: Other Visions of Our World, by Sandra Sinclair, Foreword by Dean Yeager, Ph.D. (Publication date: May 7, 1985; Price: \$24.95, hardbound).

An entertaining, informative, and visually stunning exploration of the amazing range of vision among our fellow creatures, the book depicts, through breathtaking color photos, how the world may appear to animals on every step of the evolutionary ladder, from the chambered nautilus and the rattlesnake to hawks, monkeys and even dragonflies.

Written with the assistance of leading experts in animal perception, this extraordinary volume covers such topics as:

- * the enormous diversity of eyes in the animal kingdom
- * how nature has adapted certain eyes for night vision
- * how the eye and brain work together to form a coherent picture
- * special powers of perception, such as the ultraviolet vision of the bee and the infrared "vision" of certain snakes.

In 150 color and 5 black-and-white photographs, HOW ANIMALS SEE gives readers a glimpse into the amazing realm of creatures with eyes on turrets, compound eyes, eyes that see in the depth of the seas and eyes that perceive tapestries of colors invisible to us.

The book also broadens readers' horizons with often surprising facts, including:

- * Successive images flash before the human eye at a rate of 60 per second during the day. That is why a film that moves before our eyes at 24 frames per second appears to be continuous. By contrast, a bee's images move more rapidly, at 300 per second. Thus a motion picture would appear to its eyes as nothing more than a series of still pictures.

NEW BOOK RELEASE:

- * *The hawk's vision is sometimes estimated to be eight times as sharp as our own. Birds of prey can frequently see an object on the ground when we cannot even see the bird in the air.*
- * *The douroucouli, a monkey of South America, is the only known nocturnal primate, and its eyes are so sensitive that if they are exposed to daylight for any length of time, the animal can go blind.*
- * *The color vision of many insects extends into the ultraviolet area of the spectrum. Markings on flowers which are invisible to our eyes show insects the way to pollen, like landing lights at an airport.*
- * *The eyes of the rabbit are placed so far back on the sides of its head that it has almost 360-degree vision.*

Visually astounding and factually compelling, **HOW ANIMALS SEE** may change forever the way you look at your world and your fellow creatures.

SANDRA SINCLAIR is a writer and film maker. She lives in New York with her daughter and animals.

HOW ANIMALS SEE: Other Visions of Our World

By Sandra Sinclair, Foreword by Dean Yeager, Ph.D.

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Index. Bibliography. 150 color illustrations, 5 black-and-white.

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SPECIES OF SPECIAL CONCERN IN PENNSYLVANIA

edited by H. H. Genoways and F. J. Brenner

Now for the first time anywhere, all of the data for the rare and endangered flora and fauna of Pennsylvania can be found in one place. This book is meant to be the blueprint for action in saving the most endangered and threatened portions of the flora and fauna of the Commonwealth. This action is the responsibility of several state agencies, professional scientists, and the general public of the Commonwealth.

This book represents the best estimation of the Pennsylvania Biological Survey of the status of the species of special concern in Pennsylvania. Species considered to be of special concern are those that are classified as endangered, threatened, vulnerable, status undetermined, and extinct or extirpated. The data assembled for each species are grouped under the headings of common name, description, range, habitat, life history and ecology, basis of status classification, and recommendations for future action. The accounts for the individual species also include citations to more extensive information concerning the species. With the passage of time, the data in this book will become outdated; however, these data will always be the baseline against which future studies will be measured. This book will be a basic reference for anyone who is concerned about the environment and is interested in conserving our natural resources.

The book opens with chapters on Aquatic and Terrestrial Habitats, Physiographic Provinces, Drainage Patterns, and Definitions of Status Categories used. The remaining six chapters are devoted to plants and five major animal groups. The chapter on plants gives information on 21 endangered species of plants. The animal groups covered are invertebrates represented by accounts for 62 species, fishes by 62 species, amphibians and reptiles by 18 species, birds by 39 species, and mammals by 34 species. There are two distribution maps (Pennsylvania and

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Status Undetermined—*Eumeces anthracinus*; *Clonophis kirtlandii*; *Heterodon platyrhinos*.

Extirpated—*Ambystoma tigrinum*; *Pseudotriton montanus*; *Emydoidea blandingii*; *Trionyx muticus*.

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A NEW JUMPING VIPER, *Porthidium olmec*,
FROM SOUTHERN VERACRUZ, MÉXICO
(SERPENTES: VIPERIDAE)

Gonzalo Pérez-Higareda, Hobart M. Smith and Jordi Julià-Zertuche

Abstract

A population of Jumping viper from the Los Tuxtlas uplands of southern Veracruz is differentiated as a new species from other members of the *nummifer* superspecies on the basis of fewer ventrals (103-115 vs. 120-155), more numerous anterior dorsal scale rows (27-28 vs. 21-25), and certain features of color and pattern. Burger's 1971 arrangement of genera and species of México and Central America of *Bothrops auctorium* is reviewed and adopted.

Seven specimens of *Porthidium* collected from isolated hills of the mountainous Los Tuxtlas region, Veracruz, México, are surprisingly distinct from the adjacent species *P. nummifer*, although closely related. We here regard them as representative of a distinct species,

Porthidium olmec sp. nov. (Figure 1)

Holotype. No. 1300 in the Los Tuxtlas herpetological collections of the Universidad Nacional Autónoma de México (UNAM-LT), adult female, crest of Cerro Egega, 1100 m, municipality of Catemaco, Sept., 1981, Gonzalo Pérez-Higareda.

Paratypes. Six: UNAM-LT 2338, adult female, Colonia Lázaro Cárdenas, 700 m, municipality of San Andrés Tuxtla, Sept. 1984, same collector; JJZ (personal collection of Jordi Julià-Zertuche, held in the Instituto Nacional de Higiene, S.S.A.) 291, adult male, Cerro Buenavista, 750 m, municipality of Catemaco, Dec., 1973, Abraham Ramírez; and four specimens (one male, three females), UNAM-LT 2474-7, the last to be deposited in the University of Colorado Museum, Arroyo Claro, Sierra de Santa Marta, 1100 m, same municipality.

Diagnosis. A member of the *nummifer* superspecies of *Porthidium*, differing from all other members in a lower number of ventrals (103-115 vs. 120-155); and from all except *P. picadoi* by a higher number of anterior scale rows (27-28 vs. 21-25).

Description of holotype. Internasals 2/2, borders raised; nasorostrals 3/3; nasal completely divided into preseminal and postseminal; preseminal touching first labial; canthals 1/1; postcanthals 3/3; loreals 1/1; preoculars 2/2; supraoculars entire, without transverse

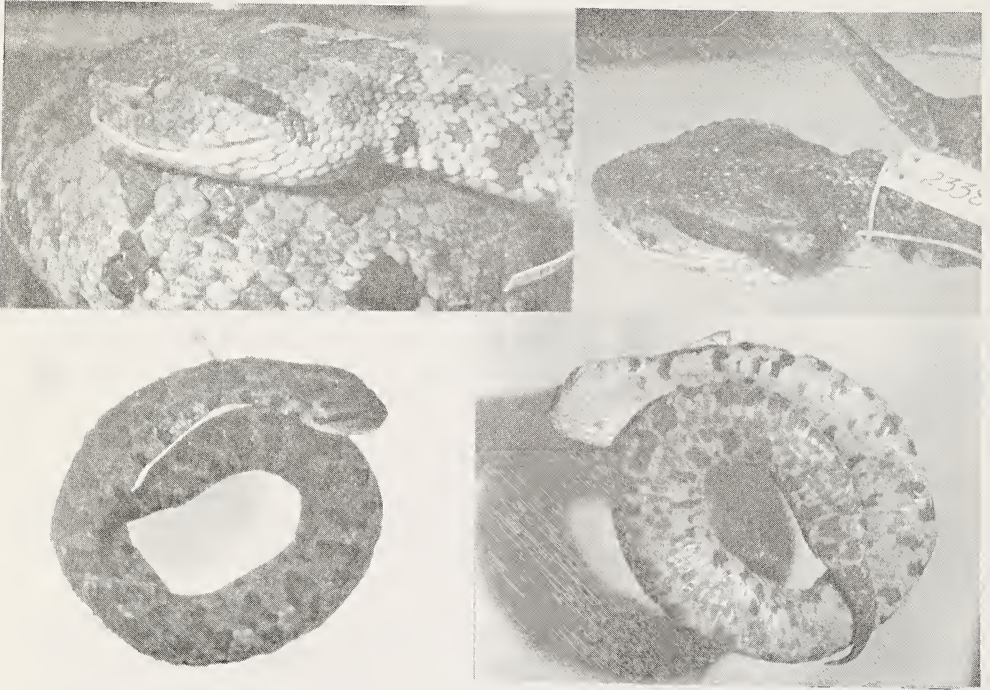


Figure 1. *Porthidium olmec*. No. 2338 is a paratype; all figures except the one with that number clearly in view are of No. 1300, the holotype. See text for measurements and localities.

suture; infraocular enlarged, elongate; rostral triangular, separated from prenasals by nasorostrals; supralabials 10/10, 4th and 5th largest; infralabials 12-12, 5th small; chinshields in medial contact, separated from ventrals by three pairs of gulars, in contact with first and second infralabials; dorsal scale rows 28-23-19, keel reaching to tip of each scale, weakly knobbed; ventrals 112; subcaudals 25, all entire.

Total length 660 mm, tail 60 mm; head width 35 mm.

Dorsal color brown in alcohol, reddish in life; head with postocular dark band, on right side three scales wide, from orbit diagonally across posterior labials to an expanded spot involving 4th and 5th sublabials (for left side Figure 1); a pair of elongate, dark nuchal spots. Body with 24 middorsal, dark brown blotches, light yellow-bordered, completely separated from each other; 23 dorsolateral black blotches, separated from dorsals; tail dark brown. Venter cream, with a longitudinal series of irregular dark spots on each side, covering edges of two to four ventrals and first and second dorsal scale rows; ventrals strongly spotted and pigmented; subcaudals black; gular area yellow in life.

Variation. Table 1 summarizes the variation in the type series in most important characters. The dorsal blotches are separate in most, but, in some, fused in a sinuous (not zig-zag) band anteriorly or (in JJZ 291) from the 5th to the 21st blotch; the dorsolateral blotches are separate from each other and from the dorsal blotches in all. The reddish dorsal color is constant except in the specimens with fused dorsal blotches, in which the dorsal color is reddish gray.

Comparisons. The most salient distinction between *P. olmec* and its relatives is in number of ventrals, with 103-115 (\bar{x} 109) in *P. olmec* as opposed to 129-134 (\bar{x} 132; $N=19$) in samples we have examined of the *nummifer* superspecies from central-western and northern Veracruz, and from the Huasteca region of Hidalgo, Querétaro and Veracruz. According to Peters and Orejas-Miranda (1970: 41), the Central American forms of *P. nummifer* (referred by them to *P. m. mexicanum* and *P. m. occiduum*) have a greater range in ventral number, 121-134, but still distinctly higher than in *P. olmec*. Smith (1943: 400-401) records 120-134 in 14 specimens of *nummifer* from Veracruz, Hidalgo and Puebla, and 124-129 in *mexicanum* from Chiapas and Guatemala. At the opposite end of the geographic range of the superspecies, *P. picadoi* has a still higher number of ventrals, 141-155 (Werman, 1984). Wilson and Meyer (1982: 130) record a range of 114-128 ventrals in Honduras material, overlapping by one (however, three specimens of seven) the range in *P. olmec*. There is, however, no overlap between the counts for *P. olmec* and its adjacent taxon of this complex (see following discussion of relationships). The taxon of Honduras is not the same as the widely distributed trans-Isthmian Mexican taxon (vide infra).

A second distinguishing character of *P. olmec* is its high number of anterior scale rows, 27-28, as opposed to 21-25 (\bar{x} 23; $N=19$) in the series of *nummifer* noted above. *P. picadoi*, however, has an overlapping range (25-29, fide Werman, 1984). Smith (1943: 400-401) recorded a range of 21-25 (only

Table 1. Variation in *P. olmeca*

Specimen No.	sex	nasorostrals	supralabials	infralabials	dorsal scale rows	ventrals	subcaudals	dorsal body spots	fused dorsal spots	lateral body spots	tail tip	snout-vent length mm	tail length mm
UNAM-LT 1300	f	3/3	10/10	12/12	28-23-19	112	25	24		23	dark	600	60
UNAM-LT 2338	f	3/3	11/11	13/13	28-23-19	115	27	19	+	19	dark	490	55
JJZ-291	m	0/0	10/10	11/11	27-23-19	115	30	24	+	23	dark	467	58
UNAM-LT 2474	f	3/3	12/12	13/13	28-23-19	103	29	22		21	dark	601	60
UNAM-LT 2475	m	3/3	11/11	12/13	28-23-19	103	25	22		21	dark	521	59
UNAM-LT 2476	f	3/3	11/12	12/12	28-23-19	115	25	24	+	20	dark	700	70
UNAM-LT 2477	f	3/3	11/11	12/13	28-23-19	105	25	22		20	dark	468	57

one with 25) in 13 *nummifer* (see above), although four counts for *mexicanum* (see above) were 23, 25, 25 and 27. Wilson and Meyer's (1982: 130) counts (23-31) for this character overlap those of both *P. olmec* and the widespread trans-Isthmian Mexican taxon of this complex, but as noted previously their Honduras taxon is not the same as either indicated taxon of Mexico.

Average differences occur also in number of supralabials and infralabials (10-12, 11-13, respectively, in *P. olmec*; frequently 9, never more than 10 supralabials, frequently 9 or 10 infralabials, rarely 13, in *P. picadoi* and our *nummifer*). Less tangible differences in color and pattern exist; particularly distinctive is the reddish coloration of *P. olmec* and its extensive dark ventral markings (immaculate or lightly spotted in all *nummifer*-like populations, and in *P. picadoi*; Peters and Orejas-Miranda, 1970: 41).

Etymology. The specific name refers to the ancient Olmec tribe of southern Veracruz where this species occurs, as well as of adjacent areas in Tabasco. It is a noun in the nominative singular, in apposition with the generic name.

Relationships. The genus *Porthidium* was regarded by Burger (1971a: 131-132) to be comprised of three species groups, one of which, the *nummifer* group, contained *P. melanurum* and *P. nummifer* (with four subspecies). The closest relatives of *P. olmec* are in this group. *P. melanurum* has the supraocular scale extended as an elongate, hornlike structure, hence is readily distinguishable from all others of its group, including *P. olmec*. *P. picadoi*, which Burger (loc. cit.) regarded as a subspecies of *P. nummifer*, is now generally accepted as a full species, most notably by its latest revisor (Werman, 1984). It is so geographically distant from *P. olmec* and so different in ventral count that it is not likely to be as closely related to *P. olmec* as some of the remaining members of the group. It nevertheless obviously belongs to the *nummifer* superspecies, which excludes only *P. melanurum* of the *nummifer* species group.

The remaining taxa of the *nummifer* superspecies are sorely in need of monographic review. The uncertainties are not so much the distinctness of the four populations to which names have been applied (the "southern," *nummifer* or *mexicanum*; the "northern," *nummifer* or *veraecrucis*; the Pacific Guatemala - ?Chiapas - ?El Salvador, *occiduum*; and the Los Tuxtlas, *olmec*), but whether they intergrade and hence are subspecies, or should be considered as full species, and to which taxon the enigmatic name *P. nummifer* itself belongs. Burger (1950) thought it belonged to the "southern" form, whereas Mertens (1952) placed it with the "northern" form; both based their conclusions on data from the holotype. The numerous comments on the problem in the literature that have accumulated since then are highly confusing and are succinctly summarized by Wilson and Meyer (1982: 130-131). Clearly, no definitive conclusions are possible without more critical and comprehensive study.

Nevertheless we are convinced that most of the difficulties have arisen from emphasis upon pattern and cranial scale characters that are

subject to intrataxonomic variation, whereas the more meaningful characters of body proportions and scale characteristics have been neglected, although they were noted when the "northern" and "southern" taxa (as designated by Neill and Allen, 1960: 156, 158-9) were first distinguished (Smith, 1943: 400). The "southern" taxon has a disproportionately large head and short, thick body (see Alvarez del Toro, 1982: 208, figs. 161, 162), whereas the other members of the *nummifer* superspecies are of "normal" proportions. Differences between related taxa in body proportions are difficult to quantify, but are nonetheless significant; *Crotalus tigris* is a pertinent example of a taxon that was long misinterpreted until body proportions were taken into proper account as a guide to otherwise hidden character correlations. In addition the "southern" form has a pronounced vertebral ridge and, more importantly, an extraordinary knob accentuating the keel on each of the middorsal scales on the anterior part of body, giving the snake a formidable, bristling appearance. Furthermore, the keel does not reach the posterior edge of the scale - a character of documented importance (Peters and Donoso-Barros, 1970: 39-42) in distinguishing species of *Bothrops* (auct.). In the "northern" form the keel on each dorsal scale reaches the posterior tip of the scale, and the knob is poorly developed. We suspect that pattern and detailed head scale variation at least in part obscure these more fundamental distinctions, which we regard as indicators of specific rank. Thus we interpret all taxa of the *nummifer* superspecies as full species, except for *occiduum*, the validity of which is still uncertain. Since Mertens is the only recent author to have directly examined the holotype of *nummifer*, we tentatively accept his allocation of that name with the "northern" species (1952: 79), leaving *mexicanum* for the "southern" one. That arrangement conforms with the nomenclature adopted by Smith and Taylor (1945: 182) and Burger (1971a: 132).

Although we are convinced that *P. olmec* is a valid taxon of restricted distribution, differing markedly from adjacent and other taxa of the complex, obviously far more study of the complex than we can undertake will be required to provide a definitive picture. Our recognition of *P. olmec* points out another problem for future elucidation; we cannot pretend to provide final answers here even to the Mexican components of the complex.

We see no alternative, however, to the tentative conclusion that *P. olmec* is a specialized and highly localized derivative of the adjacent (and perhaps partly sympatric; see Pérez-Higareda, 1978, for the only records from southern Veracruz, in the Los Tuxtlas region) *P. nummifer*, differentiated through isolation in the Los Tuxtlas biotic province. In what way its distinctive characters are adaptive - if indeed they are not drift or founder in origin - is not apparent. We interpret *P. picadoi* as a parallel, highly localized isolate derived from its adjacent *P. mexicanum*, although its distinguishing characteristics are widely different from those differentiating *P. olmec* from its parent stock, *P. nummifer*.

Generic allocation. The highly speciose and polyphyletic *Bothrops* auctorum was first partitioned generically in nomenclaturally acceptable form, in modern times, by Burger (1971b) whose published abstract was based upon a nomenclaturally unavailable dissertation (1971a) which nevertheless is

Indispensable for clarification of the abstract. The latter made clear that he recognized five genera where before one was accepted: *Bothriechis*, *Bothriopsis*, *Bothrops* s.s., *Ophryacus* and *Porthidium*. His dissertation noted all species then known belonging to these genera, and provided skeletal and scutellational documentation for his genera.

In a posthumous publication, Hoge accepted all genera except *Ophryacus* recognized by Burger (whose dissertation was the only source cited), but his review was based primarily on epidermatoglyphics and was very incomplete (Hoge and Romano-Hoge, 1983: 84, 87, 90). His untimely death interrupted a projected monographic review early in its development. His assignment of species of *Bothrops* s.l. to the four genera he recognized differs somewhat from Burger's, but because his study was so preliminary, incomplete, and subject to revision, Burger's allocations remain the most reliable. The main contribution by Hoge and Romano-Hoge, in this context, is their acceptance of the concept of generic partitioning introduced by Burger. In the interest of long-overdue clarification of the main outlines of Burger's reclassification, particularly for the benefit of those dealing with Mexican and Central American herpetology, we here submit the following comments and quotations.

The heart of Burger's differentiation of the five genera replacing *Bothrops* auctorum is embodied in his key (Burger, 1971a: 83), the pertinent part of which is quoted as follows (all quoted passages here reproduced should be referred to as of Burger, in Pérez-Higareda et al., etc.):

- "9. Terrestrial; tail not prehensile----- 10
 - Arboreal; tail prehensile----- 11
- 10. Subcaudals entire; palatine rounded, not forked
 - anteriorly----- *Porthidium*
 - Subcaudals divided; palatine forked anteriorly----- *Bothrops*
- 11. Subcaudals entire; lateral caudal scales strongly
 - keeled distally----- *Bothriechis*
 - Subcaudals divided or anteriorly entire and posteriorly
 - divided; lateral caudal scales having keels reduced from
 - anterior to posterior----- 12
- 12. Eyelash scales; Interoculars 11 or more; anterior
 - border of maxillary cavity divided into two distinct
 - curvatures by rounded projection----- *Ophryacus*

No eyelash scales; Interoculars 10 or less;

anterior border of maxillary cavity a simple

uninterrupted curve----- *Bothriopsis*"

Burger (op. cit.: 114) stated that "*Ophryacus* is monotypic, comprising *O. undulatus*." To that we add *O. sphenophrys*.

In *Bothriechis* Burger (op. cit.: 117) recognized two groups, as follows: "*Bothriechis nigroviridis* group: *B. aurifer aurifer*, *B. aurifer marchi*, *B. bicolor*, *B. lateralis*, *B. nigroviridis*; *Bothriechis schlegeli* group: *B. schlegeli schlegeli*, *B. schlegeli nigroadspersus*." To these we add *B. nigroviridis rowleyi*, *B. n. macdougalli* and *B. ornatus*.

Bothriopsis, as recognized by Burger, is a strictly South American genus, hence extralimital in the context of the present review.

Bothrops sensu Burger is likewise limited to South America except for West Indies (Lesser Antilles) species, and *B. asper* which extends through Central America to Tamaulipas, México.

Porthidium was regarded by Burger (op. cit.: 131-132) to be comprised of eight species in three groups as follows: "*Porthidium godmani* group: *P. barbouri*, *P. godmani*...; *Porthidium lansbergi* group: *P. hyoprorum*, *P. lansbergi lansbergi*, *P. lansbergi dunni*, *P. lansbergi yucatanicum*, *P. nasutum*..., *P. ophryomegas*; *Porthidium nummifer* group: *P. melanurum*, *P. nummifer nummifer*, *P. nummifer mexicanum*, *P. nummifer occiduum*, *P. nummifer picadoi*." To this list we add *P. olmec* in the *nummifer* group, *P. hesperis* in the *lansbergi* group, and *P. tzotzilorum* in the *godmani* group.

The Mexican species of *Bothrops* sensu lato therefore fall into four genera, as distinguished by Burger (1971a, b). Since in our experience these are all extremely well-defined, natural groups, we accept his partitioning enthusiastically and without reservation.

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NOTES ON THE GREEN SALAMANDER, *Aneides aeneus*,
IN MARYLAND

Edward L. Thompson and Gary J. Taylor

Abstract

We further describe the distribution of *Aneides aeneus* in Maryland by searching potential microhabitat characterized by shaded outcrops of Pottsville sandstone. Forty-one (41) previously unknown sites for this Maryland-listed endangered species were identified. All localities were from northwestern Garrett County in the Allegheny Plateau physiographic province. Peak activity for this species occurred in May, and again from mid-September to early October. We report other life history observations and data. We suggest that the status of this species in Maryland could be down-listed from endangered to threatened.

Aneides aeneus was reported from Monongalia County, West Virginia in 1932 (Netting and Richmond, 1932), but it was not until September 1966 that it was discovered in nearby Garrett County, Maryland (Harris and Lyons, 1968). In the few years after its initial discovery, this salamander was recorded from two additional localities in the state (Harris and Lyons, 1968; Norden, pers. comm.). Until recently, these were the only known colonies of *A. aeneus* in Maryland. Because of concern voiced by the Maryland Herpetological Society, it was added to the state's Endangered Species List in 1972 (Annotated Code of Maryland, Article 66C, Section 125). Since other rock formations of the same type as the documented localities were known in Garrett County, it was speculated that other populations may be found with additional field studies (Harris and Lyons, 1968). In July 1980, the Maryland Wildlife Administration (now the Maryland Forest, Park and Wildlife Service) initiated a survey to determine the status and distribution of *A. aeneus* in Maryland.

Because *A. aeneus* is restricted to specific rock types (Netting and Richmond, 1932; Gordon, 1952), a county geologic map was used to identify general areas to search for habitat. In the northeastern part of its range, *A. aeneus* has only been reported from (or in the vicinity of) shaded, massive sandstone outcrops of the Pottsville geologic series (Netting and Richmond, 1932; Richmond, 1952; Harris and Lyons, 1968). More specifically, it appears to be restricted to the Homewood sandstone of the Pottsville series (Maryland Geologic Survey, 1902; Hickok and Moyer, 1940). U.S.G.S. 7.5 minute topographic maps were used during ground reconnaissance and subsequent mapping of localities. The primary survey procedure was vehicle reconnaissance by four-wheel drive supplemented with extensive foot travel. Much of the area is relatively isolated and rugged. Field time was divided between searching for *A. aeneus* and two state endangered reptiles, *Virginia valeriae pulchra* and *Eumeces anthracinus anthracinus*. *Aneides aeneus* habitat was searched for during all times of the year, but late fall to early spring proved to be a particularly good time to locate large rock formations because

of the lack of vegetative cover. When the salamanders were active, the crevices within the identified rock outcrops were carefully and systematically searched with a flashlight for the presence of *A. aeneus*. Sites were sampled more than once, when necessary. Initially, sampling was done both day and night. As the survey progressed, it became apparent that *A. aeneus* could be discovered just as easily during the day as at night. In addition, much of the terrain was too rugged to travel safely at night. Thereafter, night sampling was only conducted to gather salamander activity information. Several colonies were monitored at regular intervals throughout the field season. Rocks other than the Pottsville sandstone were occasionally searched, especially if their gross appearance suggested that they were potential habitat.

Within a given rock formation, crevices of specific geologic structure and moisture conditions are necessary for *A. aeneus* to occur (Gordon, 1952). Damp and very narrow exfoliation and fracture cracks appear to be preferred (pers. obs.). The necessary microhabitat is not always found in the rock formation with which the salamanders are generally associated. Many rock outcrops appearing to be suitable habitat were found to be unsuitable after closer inspection. In fact, more searches of Pottsville outcrops resulted in failure rather than success in locating *A. aeneus*. This was primarily due to the overall dryness of available crevices or an outright lack of crevices. Furthermore, numbers of individuals observed varied greatly among habitats sampled at the same time of year. For instance, an intensive search of one outcrop may yield only two or three individuals, while in another of similar size as many as 30 individuals could be observed. In some instances, microhabitat was obviously ideal as the salamanders were found in relatively high numbers (50-60 individuals). Although no attempt was made to quantify microhabitat characteristics, it is obvious from our field observations that the crevice requirements of *A. aeneus* are very stringent. Gordon (1952) found that the characteristics of *A. aeneus* breeding crevices are more specific than other crevices used, i.e., transitory crevices. Our investigations agree with this, and it would seem reasonable to assume that a lack of suitable breeding crevices is a primary limiting factor in the distribution of *A. aeneus*.

From July 1980 to October 1982, 41 new localities for *A. aeneus* were found in Maryland. Although Pottsville sandstone was sampled throughout Garrett County, all populations are restricted to the northwestern portion of the county and are associated with the Youghiogheny River drainage basin (Figure 1). All colonies are restricted to rocks of the Pottsville formation; and, as near as the authors can determine, the Homewood sandstone. Because of their specific habitat requirements, *A. aeneus* range in Maryland is made up of disjunct, isolated populations, although many are relatively close to one another. This is not unlike the situation reported throughout its entire range (Gordon, 1967).

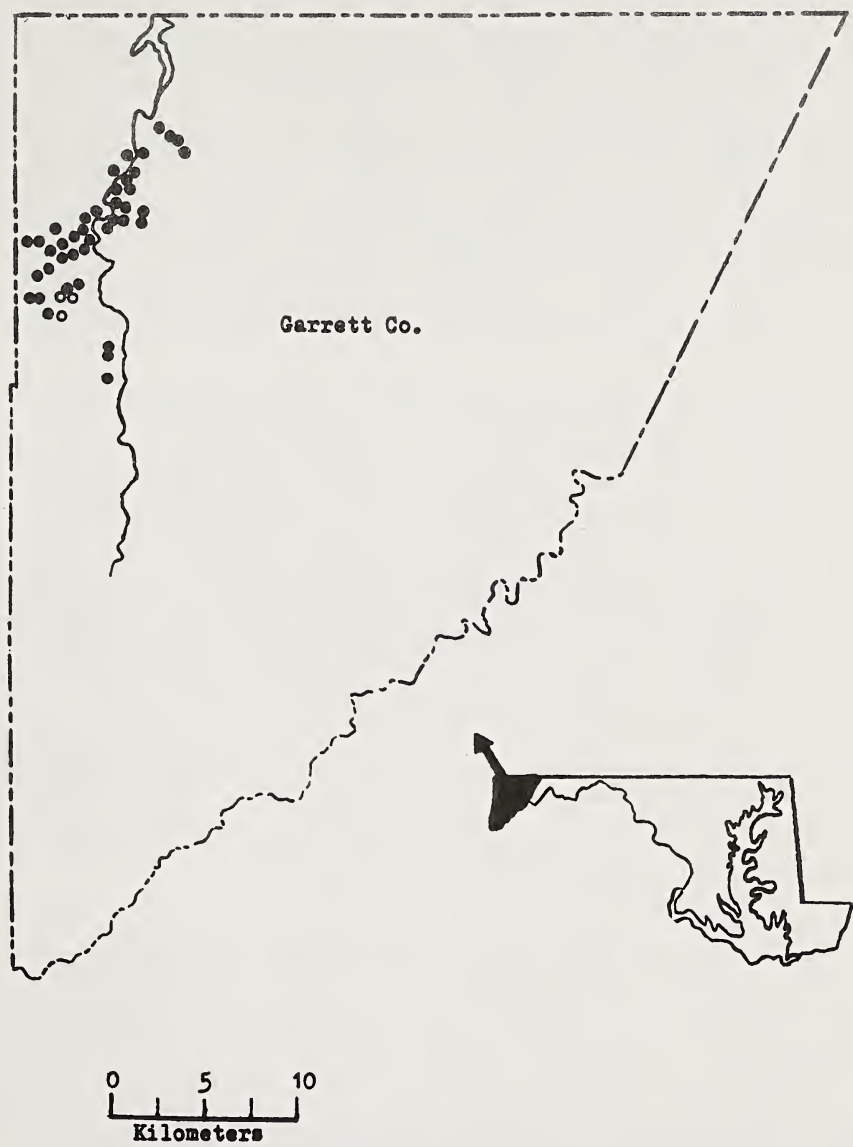


Figure 1. Distribution of the green salamander, *Aneides aeneus* in Maryland. Open circles depict localities known prior to this study.

Gordon (1952) found that adults of this species are quite sedentary with relatively short migrations to and from breeding and hibernation crevices. Preliminary mark-recapture studies conducted during our survey agree with these findings. However, long-term studies would be needed for making definitive conclusions. *Aneides aeneus* has been reported from arboreal situations (Gordon, 1952). In these situations we suspect rock habitat was nearby. Of 1,175 *A. aeneus* observations made during our survey, none were recorded away from the rock habitat. However, intensive searches were only conducted in the immediate vicinity of rock habitat, and this was not done with any regularity. One individual was observed in a crack formed by rock and a large root. After repeated sampling of several colonies it was discovered that the number of individuals observed did not vary greatly between day, dusk, or night. After dark, however, the salamanders are much more likely to be near the entrance of a crevice or be out on the face of the rocks.

Practically no life history information has been gathered for *A. aeneus* in Maryland (Maryland Herpetological Society, 1973). In North Carolina, Gordon (1952) recorded definite seasonal periods when *A. aeneus* was more active near the surface of a rock formation. Our observations show similar results. Figure 2 represents two colonies that were regularly monitored. During 1982, actual sampling for the salamanders was begun in mid-March. The earliest observation, of a single individual, was recorded on April 14. Activity gradually increased from this date on, and peak spring activity occurred in May. From mid-June to early August, *A. aeneus* was difficult to find. However, if brooding females were discovered, they could be observed throughout the summer. Beginning in late August, surface activity again begins to increase with peak numbers observed from mid-September to early October. At any given colony, the highest number of individuals were observed during this period. During 1982, the last *A. aeneus* observation was recorded on November 7. Gordon (1952) suggested that fall would be the best time of the year to sample an *A. aeneus* colony, and he showed that the increased visibility of the population is due to the salamanders migrating to and congregating near hibernation crevices. This phenomenon was readily apparent during our investigation.

Several other interesting observations were recorded during our survey. The earliest date on which a brooding female was observed was June 8, 1982. Gordon (1952) suggested that the main breeding period for *A. aeneus* was during the spring in North Carolina. He also recorded brooding females in early June. In Kentucky, Cupp (1971) observed courtship behavior in this species during the fall. Based on young-of-the-year and brooding female observations, the majority of the breeding activity in Maryland appears to occur from mid-May to early June. With the exception of a single individual seen on April 27, 1982, all young-of-the-year (less than 15 mm SVL; 102 total observations) were recorded from early September through mid-October (Figure 3). Gordon (1952) reported a brooding period from 84 to 91 days for *A. aeneus* in North Carolina. The earliest fall data on which newly hatched young were observed in Maryland was September 9, 1981. During 1982, recently hatched young were first seen on September 12. In contrast to the regularity of the appearance of young, females with ova visible through

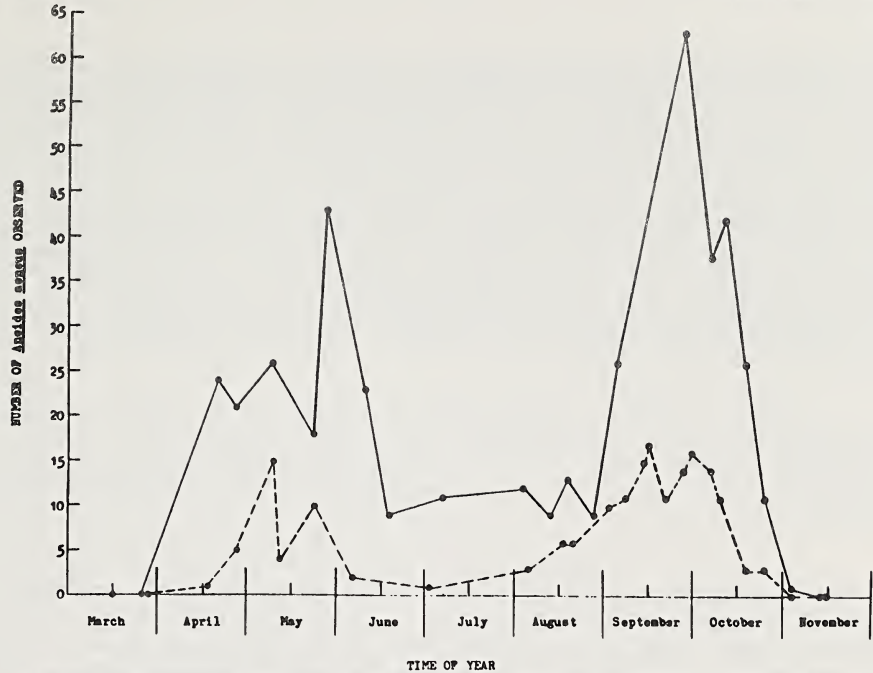


Figure 2. Changes observed in the surface activity of *Aneides aeneus* during 1982 at two study areas in Maryland. Young-of-the-year observations are not included.

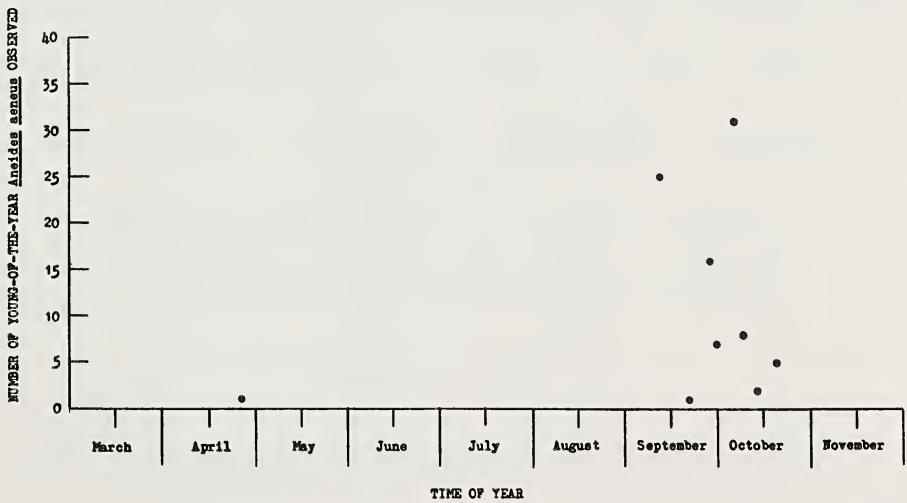


Figure 3. Total young-of-the-year *Aneides aeneus* observations made during the late 1982 field season in Maryland.

the ventral surface were observed throughout the field season, particularly during August to October. Several were seen during mid-October, just before hibernation is expected to begin in this region. These females were observed to be comparatively heavy, and the tail was thick with fat. By contrast, females that have participated in the season's egg-laying and brooding were very emaciated when encountered during October. It would seem that these emaciated individuals could not be physiologically prepared to participate in the next spring breeding. Instead, the females with well developed fat deposits and ova visible are probably the participants in the next breeding period. Although these preliminary observations allow only for speculation, it appears that most individual female *A. aeneus* do not take part in the breeding cycle on an annual basis.

Thirteen females brooding eggs or with recently hatched young were observed during our investigation. The dimensions for seven breeding crevices are given in Table 1. All observed breeding crevices were horizontally positioned, or hole-like, with the eggs or remains thereof attached to the roof.

One-hundred and seventy-five *A. aeneus* were measured (SVL only) in the field to the nearest millimeter. An interesting habit of *A. aeneus* facilitated measuring live specimens. Invariably, individuals could be coaxed to play dead, most with minimal provocation. They would become limp and were easily straightened out in the hand and placed venter up. Netting and Richmond (1932) and Gordon (1952) reported this behavior in juveniles.

Table 1. Dimensions of seven *Aneides aeneus* breeding crevices from various colonies in Maryland. All measurements are in centimeters.

<u>Crevice #</u>	<u>Max. height at entrance</u>	<u>Max. width at entrance</u>	<u>Depth of eggs</u>
1	1.0	10.0	8.5
2	2.0	8.1	20.0
3	1.9	5.0	6.2
4	0.8	5.3	6.0
5	2.0	14.8	12.1
6	0.7	4.5	9.0
7	1.1	4.0	17.9

Gordon (1952) and Cupp (1980) described external secondary sexual characteristics which distinguish the adults of *A. aeneus*. Based on these characteristics, 79 sexually mature individuals were measured during our investigation. No attempt was made to examine internal reproductive condition, with the exception of viewing ova through the ventral surface of females. The smallest male measured with well developed secondary characteristics was 52 mm SVL. Similarly, the smallest female measured with visible ova was 52 mm SVL. Of 34 adult males measured, the average length was 59 mm SVL (59.1) and largest was 69 mm SVL. Of 45 adult females measured, the average was 60 mm SVL (59.8) and the largest was 67 mm SVL. Six young-of-the-year were measured, and they varied between 13 and 15 mm SVL. No individuals between young-of-the-year size and 25 mm SVL were encountered.

Elevation of *A. aeneus* localities (obtained from 7.5' topographic maps) ranged from 488 m to 829 m above sea level with an average of 643 m. This differs little from the elevational extremes in this section of Garrett County which are 457 m and 914 m above sea level. All of the county lies within the Appalachian Plateau physiographic province.

Other species of salamanders were also observed in crevices while searching for *A. aeneus*. These include *Desmognathus ochrophaeus*, *Plethodon glutinosus*, *P. cinereus*, *P. wehrlei*, *Eurycea longicauda*, *E. bislineata*, and *Gyrinophilus porphyriticus*.

Although 43 localities are now known for this species in Maryland, it is still an animal of special concern because of its extremely localized distribution and the small populations apparently existing at many sites. However, several localities support very good populations, and if protected from outright destruction and indiscriminate collecting, *A. aeneus* should remain as an element of the Maryland herpetofauna. The results of this investigation support a recommendation to down-list *A. aeneus* from endangered to threatened status in Maryland.

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NOCTURNAL ACTIVITY IN CAPTIVE BROWN TREE SNAKES
(*Boiga irregularis*)

Abstract

Eight specimens of *Boiga irregularis* from Guam were maintained in a North American laboratory with a 12 hr L - 12 hr D photoperiod (light onset at 0700). Temperature was constant at $26 \pm 1^\circ$ C. Three measures of activity indicated that these animals, known to be nocturnal in Guam, continued to exhibit a nocturnal pattern of activity in the laboratory.

The brown tree snake (*Boiga irregularis*) is known to be nocturnal in its natural habitat (northern Australia, Solomon Islands and New Guinea; Cogger, 1975; Smith, 1943; Taylor, 1922; Worrell, 1963) as well as in habitat to which it has been introduced (Guam; Fritts, unpublished ms; Sheppard, 1985). The impact of *B. irregularis* on the avian fauna of Guam (Engbring, 1983; Jenkins, 1983; Savidge, as cited in Sheppard, 1985) justifies research on the predatory ecology of the snakes; and it is our intention to study the stimulus control of predation upon birds and rodents. As a preliminary step in this project, it was decided to determine if specimens of *B. irregularis* exhibit a nocturnal pattern of activity under laboratory conditions.

Method

Eight individuals (50-120 cm, sv) were obtained from the Guam population through T. H. Fritts, Denver Wildlife Research Center, U.S. Fish and Wildlife Service. The snakes were maintained in individual glass terraria (50 x 27 x 30 cm) equipped with newspaper floor covers, stainless steel containers filled with water, plexiglas "hiding boxes," and dead branches (30-50 cm). Temperature of the laboratory was controlled at $26 \pm 1^\circ$ C by electric heaters, and the photoperiod was 12 hr L - 12 hr D, with the light period beginning at 0700. Snakes were offered neonatal rats and mice on a weekly schedule, and these prey were never refused.

Observations were made on a random schedule during the first month that the snakes resided in this laboratory. At each observation we recorded (1) whether the snake was on the floor of its terrarium or whether some part of its body (usually anterior) was resting on a branch, (2) whether or not any movement occurred, and (3) whether the snake was tightly coiled (Taylor, 1922) or at least partly uncoiled. A total of 60 observations were recorded for each snake.

Snakes were fed during photophase and during scotophase, and we recorded latency (sec) to attack neonatal rodents suspended from forceps. The interval between these feedings was one week. Prey were held about 2 cm from the lips of each snake during these presentations, hence no foraging was necessary in order to locate the prey.

Results

Data were partitioned into two categories, corresponding to observations taken during photophase and scotophase. The following statistics were calculated for each snake's photophase and scotophase records: (1) percent of records indicating that some portion of the body was on the branches, (2) percent of records indicating that a movement occurred, and (3) percent of records indicating that the snake was at least partly uncoiled. Then the percents were averaged over snakes for each of the phases of the light cycle. We take these values to reflect activity level (i.e., higher means indicate higher activity). Table 1 presents means and standard errors together with results of t tests for paired comparisons.

Table 1

Means Activity Scores for Eight Captive Specimens of
Boiga irregularis

	Mean percent of observations during which snakes were on branches (SEM)	Mean percent of observations during which movement was seen (SEM)	Mean percent of observations during which snakes were at least partly uncoiled (SEM)
Photophase	21.8 (10.4)	4.3 (2.1)	19.4 (12.0)
Scotophase	52.0 (5.8)	22.8 (7.0)	62.4 (8.1)
t values df=7	3.00*	2.39*	5.75***

* $p < .05$

*** $p < .01$

It is clear that each of the three measures of activity had higher mean values during scotophase than during photophase. Hence, the nocturnal pattern of activity reported to exist in nature also occurred in the laboratory. However, the mean latencies to attack prey presented in the home cages during photophase ($\bar{X}=15.3$ sec; $SEM=5.4$) and scotophase ($\bar{X}=12.0$ sec; $SEM=6.2$) did not differ significantly ($t < 1.0$).

Discussion

These results indicate that specimens of *Boiga irregularis* captured in Guam and transported to a mainland laboratory continue to exhibit an activity pattern that is comparable to that seen in their natural habitat. Although

the pattern of increased activity during scotophase might be taken to imply decreased vigilance during photophase, this idea was not confirmed by the data on feeding latency (see also Murphy, 1977). Perhaps *B. irregularis* maintained in larger environments, with prey presented at a significant distance from the snake, would exhibit faster predatory responses at night than during the daylight. On the other hand, it may be that *B. irregularis* generally remains vigilant during inactive periods, permitting the snakes to sight and even to attack prey that happen to be opportunistically available during such times. In either case, the present data support the view that these snakes are nocturnal foragers, with both horizontal and vertical movements occurring more frequently at night than during daylight.

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NEWS AND NOTES:

SUNDOWNER, THE FORGOTTEN OPHIDIOPHILE

Abstract

"Sundowner," a pseudonym for Herbert Tichborne, originally of Australia, wrote two popular books on snakes, published in 1895 and 1902, the second an elaboration on the first. Although rectification of erroneous beliefs was a stated objective, the accounts are wildly farcical. Promotion of sympathy and protection for snakes were also stated aims, but they are largely nullified for either the knowledgeable skeptic or the innocent dupe by outrageous exaggeration. The books are nevertheless landmarks, however ignoble, being among the first to appeal to the general public ostensibly on behalf of snakes, and certainly the greatest collection from a single source of fabricated nonsense about snakes. Both books are exceedingly rare, and perhaps it is just as well.

A brief summary of the more salient revelations of the books, a short extrapolation of the enigmatic Sundowner's possible life and nature, and an analysis of the significance of the works, are presented.

Although Raymond L. Ditmars is rightly regarded as the father of amateur herpetology (and of a good deal of professional herpetology, too), at least in North America, and even though he told many a tale of harrowing experiences with snakes in his long career at the Bronx zoo, he was not the first to attempt elaborately to win public sympathy for snakes. That honor, at least for the English-speaking public, should perhaps go to Catherine C. Hopley, for her book on snakes (1882), a remarkably sympathetic and informed, popular treatise, especially for its time. It is a well known work among herpetologists even today, although somewhat scarce. Far less well known - indeed virtually totally unknown - are the contributions of an obscure, enigmatic Herbert Tichborne, who wrote two popular books on snakes at about the turn of the century, under the nom de plume of "Sundowner." We here examine his contributions and as much of his life as we have been able to uncover.

The National Union Catalog of books in U.S. libraries, and the British Museum Catalog, list five books for Sundowner. The first is "Snakes" (1895), followed by "Noqu talanoa: stories from the South Seas" (1896); "Rambles in Polynesia" (1897); "Told by the Taffrail" (1901); and the last is "The Tale of the Serpent" (1902). Thus his first and last books were both about snakes. Miller and Macartney's bibliography of Australian literature (1956: 462) lists only the 1896, 1901 and 1902 books (all categorized as "fiction," although Sundowner presented them as factual narrative), but notes that his other works included the 1897 book and "From Kosciusko [an Australian park and mountain] to Chimborazo [an Ecuador mountain]" and "Above the Clouds in Ecuador."

We can find no direct evidence that other books were published under the name Sundowner, although two of his books (1897, 1901) state that he was the author of our four other works: "On the Wallaby in Maoriland," "Wildlife in the Pacific," and the two unverified titles listed by Miller and Macartney. The U.S. and British Museum catalogs list none of these four, and none is present in the excellent libraries of South Pacific works in Australia, New Zealand or Hawaii. Possibly, then, they are articles, not books, perhaps published in one of the periodical outlets in which Sundowner stated that many of the chapters of his 1896 and 1901 books first appeared.

The periodicals cited for Sundowner's 1896 book are "The Weekly Telegraph" and "The Colonies and India," and for his 1901 book, "Star" and "Field." The exhaustively complete British Union Catalogue of Periodicals, and Union List of Serials, however, list no "Weekly Telegraph" after 1865, and no British "Star" after 1857. A San Francisco "Star" ran from 1884 to 1921, but is almost certainly not the one referred to by Sundowner. However, in his 1901 book (p. 142) Sundowner mentioned a "London Star" for Dec. 31, 1899, whereas the Union List and Union Catalog state that the "London Star" ran only from 1837 to 1839. "The Colonies and India" ran from 1877 to 1898, and "Field" from 1853 to date.

We have not examined any of these journals for writings by Sundowner, but the discrepancies with the British Union Catalogue and Union List of Serials, and the absence of documentation of any of the four claimed but unsubstantiated titles as books suggest that fabrication has entered into the picture to a certain extent in these contexts as well as it most certainly has in the context of his snake books, and very likely in his other narrations.

Aside from these nine titles claimed by or documented for Sundowner, he is credited with several others from other sources. Kennedy, Smith and Johnson (1926-1934) listed a book by him entitled "Yarns from the Never-Never," 8vo, London, 1898. That work was apparently never published, and the title very likely came from some publisher's premature announcement. Ms. Rita Spurdle of the Rights Department of Chatto and Windus, publishers of Sundowner's 1901 and 1902 books, has advised us (in litt.) that "as in those days books could be printed, bound and put on sale within only a matter of weeks, it seems that titles were announced and included in the annual catalogues, with published price, even - as in one case - before the author completed this manuscript." "Yarns" almost certainly belongs to the same category, of announced but ultimately unpublished books.

Still other works apparently were written by Tichborne but never were published. Ms. Spurdle quoted (in litt.) from a letter to Chatto and Windus, from Tichborne, dated 26 February 1901: "I am now busy on 'The Voyage of the Dandenong' (25,000 words on) and I shall shortly have the pleasure of submitting it for your consideration." Nothing more is recorded of it. A biography of Sir Henry Parkes, a famed historian of Australia (especially of New South Wales, whence Tichborne presumably came) was actually submitted to Chatto and Windus for publication, but was rejected, according to Dr. J. A. Edwards, Keeper of Archives and Manuscripts in the Library of the University

of Reading, where the Chatto and Windus archives are now held. The Parkes manuscript, too, was never published, and is now lost.

Established facts pertaining to Sundowner are virtually non-existent, so far as we can determine - so few that we count ourselves fortunate even to know his supposedly real name, Herbert Tichborne. The dictionary of Australian pseudonyms (Nesbitt and Hadfield, 1972) lists "Henry" as his given name, but the National Union Catalog (with no entry under "Sundowner!"), Kennedy et al., (1926-1934), and the British Museum Catalog correctly cite him as "Herbert." Assurance that this was the given name he then used is provided primarily by membership records of the Savage Club in London, in which "Herbert" is explicit. Curiously, all transactions with Chatto and Windus were signed by, or addressed, "H. Tichborne," and on one document a clerk had erroneously written "Tichborne, Hy" as a label, perhaps giving rise to Nesbitt and Hadfield's use of "Henry" as his given name. That the "H. Tichborne" of the Chatto and Windus transactions (including acknowledgments of receipt of £30 for the 1901 book and £25 for the 1902 work) is the same as the "Herbert Tichborne" of the Savage Club is assured by a comment appended to a letter to the publisher stating that "...a note to the Savage Club will always find me quickly."

Records of the Savage Club show that Tichborne became a member in 1896, when his address was given as Editor of the "European Mail" - publisher of his first three books - Ludgate Circus, London. In 1901 Chatto and Windus addressed him at the Savage Club, then Adelphi WC; in 1902, at 33 Wyndham St. W; and in 1903, 26 Winchester Road, Hampstead NW. He had resigned from the Savage Club presumably by 1902, hence no record exists there of his death. Thus both birth and death dates are unknown, but his handwriting of 1902 suggests an elderly person.

"The European Mail" no longer exists. Dates of its founding and demise we have been unable to find. However, an advertisement in "Noqu Talanoa" (1896) states that the company had then been "established over half a century." Since one of its journal publications, "The Colonies and India," had expired by 1899 (running 1877-1898), it seems likely that the company itself ceased to exist at the same time, especially since Sundowner's publisher was switched about then from The European Mail, that handled the 1895, 1896 and 1897 books, to Chatto & Windus, handling the 1901 and 1902 books. It would be interesting to know whether Sundowner's role as Editor for The European Mail was a factor in its demise, for he had a conspicuously unskilled narrative style and was clearly dishonest in some, demonstrable contexts; his integrity in other contexts is therefore open to question.

Be that as it may, we think it likely that Sundowner, known at least through his stay in London as Herbert Tichborne, "retired" there, from his strenuous life in Australia and the South Seas, in the mid-1890's, and we doubt that he survived more than at most ten years.

Sundowner's life before London is completely unknown except for the dubious source of his own writings. We have come to suspect that the name used by him in London was an alias. The name Tichborne is highly intriguing,

for the Henry Tichborne baronetcy of Hampshire, England, traceable at least back to 1581, is of considerable fame in the history of that country and Australia. In addition, Roger Charles Tichborne (1829-1859?), elder heir to the estate following the death of his father, Sir James Francis Tichborne (1784-1862), mysteriously disappeared at sea, presumably in a shipwreck off the east coast of South America in 1859. That disappearance in itself would not be so notable, except that Lady Tichborne was convinced that Roger was alive, and advertised widely for information about him. An Arthur Orton (1834-1898) of Wagga Wagga, New South Wales, Australia - an expatriate Londoner who had served as a ship's butcher and wound up living in Chile, Tasmania and Victoria before settling in Wagga Wagga - claimed to be the lost Roger, and from 1866 to 1874 was successful enough to convince Lady Tichborne (who died in 1868) as well as numerous others that he was indeed who he claimed to be, and to force a long-drawn-out trial. He was ultimately judged guilty as an imposter, and in 1895 confessed his guilt, although under duress; he later rescinded his confession, but died in 1898 still adjudged culpable. The case received great notoriety at the time, and has been the subject of several books (e.g. Gilbert, 1957; Woodruff, 1957; and Roe, 1974; the preceding details were extracted from those sources). An excellent bibliography of "the Tichborne case" appears in Ferguson (1969: 644-648).

Internal evidence suggests that Roger Tichborne would have been about the same age as Sundowner; unlikely as it is, they still could be one and the same person. We do not endorse that possibility for various reasons, but the circumstantial similarities are intriguing. Whether Sundowner's surname entails any connection at all with the family of Sir Henry Tichborne of Hampshire remains unknown. Other Tichbornes existed at the time, certainly; Roe (1974: 145) records that "A railway stop in central New South Wales still bears the title 'Tichborne,'..."although that title was"...derived from the nickname of a miner who found gold thereabouts - a massive man, nearly two metres tall and 120 kilograms in weight." Possibly Sundowner had some connection with that person's family, adopting the nickname as his own.

Extrapolating from Sundowner's writings, we surmise that he spent his childhood in Australia; he mentioned (1902: 12) his father and their homestead in the "Wollondilly district," which Ms. Julie Stokes (pers. comm.) informs us is "...centered on a river of that name, located in southeastern New South Wales. Electoral rolls reveal no Tichbornes in the area early this century. Guides to late nineteenth century pastoral holdings and more specific directories of the Wollondilly area, as well as contemporary records (such as telephone books) reveal no Tichbornes either." By remarkable coincidence, she further points out, the town of Goulburn is situated on the Wollondilly River, and there Arthur Orton, the Tichborne claimant, under the name of Thomas Castro, assumed when he came to New South Wales in the 1860's, married Mary Ann Bryant "en route to England to claim the Tichborne baronetcy." Sundowner mentioned Goulburn as well as several other localities nearby, hence was well acquainted with the area, whether any connection exists with Orton or not. We conclude that Tichborne may well not have been Sundowner's real name, although we have no idea what it may have been; we consider it likely that Sundowner assumed the name of Tichborne when he retired to London just because its sordid fame, familiar to him as a former resident of New South Wales, appealed to his perverse, mendacious character.

Be all that as it may, Sundowner appears to have been rather well educated, whether formally or informally (we suspect the latter), for he quoted from numerous literary sources in his several books, as well as from the Bible, and his vocabulary included Fijian, French and German, as well as a surprising amplitude in English. Informal education is implied by his consistent rather crude narrative style. Rather obviously he became a drifter; there is no evidence that he ever lived long enough in one place to acquire a family, or that he ever even married. Early in post-adolescent life he probably became exactly what his pseudonym implies - a "sundowner" - "...a term applied to a type of Australian bush-wanderer... who made a habit to approach a homestead at dusk with an appeal for work, and, work being at that hour impossible, thus obtained free rations in the form of flour, mutton and tea.... The sundowner...by-passed offenders [who demanded work] and placed on his visiting list only those who welcomed him for his own sake.... People in lonely areas were, as often as not, pleased to see him, for he invariably had a stock of yarns to exchange for a trifle of hospitality. In many instances the sundowner was a man of education. His wandering life was, no doubt, either a form of escapism or a sheer delight in the open road, or both.... Today the sundowner is by way of being a legend. He flourished mainly in the 1880's and 1890's and he vanished as settlement and communications increased. He is remembered now as one whose solitary habits and peculiar open-road philosophy developed not from an idleness of the flesh but from some quirk of the spirit." (Cronin, 1958) The Cleary novel (1952) graphically reflects many aspects of the sundowner life.

The preceding characterization seems to fit our Sundowner very well; he certainly was a highly accomplished yarn-spinner and was well educated. We would, however, place his sundowning career much earlier than the 1880's, by several decades; he may well have been a sort of prototype - a forerunner - of the breed that became so well known later.

We place Sundowner's era of bush-wandering in Australia early - in the 1850's or 1860's, or probably even earlier - because his early life seemingly was spent there, and because he clearly spent many years elsewhere. Indeed, his 1901 book contains an account (pp. 85-90) that placed him in the Fiji and Society Islands during and shortly after the U.S. Civil War (1860-1865). Most of his life seems to have been spent on Fiji Islands, but New Caledonia, Samoa, and New Zealand were prominent in his accounts, and obviously time was also spent in Ecuador, the Galapagos Islands, Hawaii, and perhaps the United States (1902: 290). He was certainly familiar with England, although we assume only after the mid-1890's; he indeed dedicated his 1897 book "To my friend Thomas Robert Dewar (sheriff of London), who knows the Pacific world well, in remembrance of our many pleasant and interesting communings on travel." There was indeed a Sir Thomas R. Dewar (1864-1930), Sheriff and Lord Mayor of London, according to Philip A. Snow (pers. comm.), and he even wrote a book about the South Pacific (1894), advertised in Sundowner's 1896 book as available from (although not a publication of) The European Mail.

It appears that Sundowner at least visited, at one time or another, most areas bordering or within the South Pacific, including Central and South America. Most of the many localities where he had lived in Australia are

listed in modern gazetteers, so not many, if any, are imaginary. It is nevertheless difficult to accept that Sundowner could have lived at as many "stations" as claimed, even though various members of his family were mentioned in conjunction with several. Very likely most were simply favorite stops on his "sundowner" rounds.

Although Sundowner may have written most of his accounts as he travelled, publishing them piecemeal in various periodicals, the production of his books presumably came late in life, all five of the known volumes appearing in an 8-year span (1895-1902).

His first book, "Snakes," was superseded by and much expanded in his last one ("The Tale of the Serpent"). None of his other books overlap each other. The accounts in "Snakes" are not, however, entirely repeated verbatim in the later version; some sections of them are, to be sure, but others are more or less extensively rewritten. More than twice as much material is included in the later book than in the first one.

Both books on snakes, however, are extremely rare, to judge by the fact that no copy of "Snakes" is listed in the National Union Catalog (noting the contents of all sizeable U.S. and Canadian libraries), and only one library (Univ. Texas) has a copy of "The Tale of the Serpent." The British Museum has copies of all five books, and several North American, New Zealand and Australian libraries have copies of the three non-ophidian books. We possess an original copy of "The Tale of the Serpent," and have seen the other four books for comparison.

Sundowner's second book (1896) mentions no snakes, although there is a vague suggestion that an unidentified creature (a "lairo") might be a reptile (p. 77), although his account precludes that possibility. Interestingly, Kennedy et al. (1926-1934) list two editions of this work, both reportedly represented in the British Library; the first two words, "Noqu Talanoa," of the first edition are supposedly rendered "Noqu Talamoa" in the second.

Actually, two editions did appear. Dr. I. Kepars informs us that the National Library of Australia possesses two copies of each edition, and the State Library of Victoria has a copy of the second. The title is rendered the same in both editions, hence the different spellings recorded in Kennedy et al. (1926-1934) are an error, probably clerical. Both editions bear the same imprint of 1896, but "one is indicated as being the second edition and is cheaper, having a paper spine with board back and front covers" (Kepars, pers. comm.). Several Australian and U.S. libraries contain copies of the first edition, but the only ones known to us of the second are the three previously noted in Australia. As indicated in Kennedy et al. (op. cit.), the British Library may well contain both editions.

There is a chapter in the third book (1897: 14-17) devoted almost entirely to sea snakes, whose distribution, regional variation in temperament and size are discussed. Part is reasonably acceptable, but size estimates (observed over 30 ft. long, one at 16 ft., 9 in. caught) are excessive (Malcolm Smith, 1926: xv, gives a little less than 9 ft. as the known

maximum), and the account of an enraged snake chasing a dog inland for a quarter of a mile, and attacking a defending human, is literally incredible, since sea snakes are incapable of sustained locomotion on land.

The same book (1897: 182-184) contains a description of methods used to capture sea turtles both at sea and on shore.

The fourth book (1901) contains considerably more on reptiles, especially snakes, than the preceding two. Three accounts pertain to non-ophidian reptiles - one each to turtles, crocodilians and lizards. The turtle (p. 139) is identified as a "five-hundred-pound mass of hardshelled tortoise" kept "in the little compound" near "Rosler's Hotel" at Vuna on Taviuni (= Taveuni) in the Fiji Islands. It entered the account through its name, George Washington, applied since it was presumed to be the only resident of the town never known to have told a lie. It was probably a Galapagos tortoise.

The same name was applied to a crocodile from the Solomon Islands, in a chapter devoted in its entirety to it (pp. 173-177). The Queensland crocodile (all crocodilians were called "alligators" in this chapter), presumably *Crocodylus porosus*, was contrasted in temperament (irascible) with the Solomon Islands crocodile ("genteel," tameable), but the story that centered upon an example, raised from 40 in. to over 12 ft., of the latter populations, is marred by considerable fabrication and exaggeration. The specimen supposedly was sent finally to the Sydney zoo. No current basis exists for taxonomic recognition of more than one species of crocodilian, *C. porosus*, the formidable estuarine crocodile, in the Fiji or Solomon Islands. The same species occurs in northern Australia and throughout the East Indies, but is everywhere much feared through its large size (to 20 ft.) and frequent attacks upon humans. A much smaller species (*C. johnstoni*), 9 ft. maximum, occurs in northern Australia, and another (*C. novaeguineae*, 8 ft. maximum) in New Guinea (data on all South Pacific species from Neill, 1971). Both are relatively gentle species. Perhaps Sundowner was aware of one or the other of these smaller, relatively innocuous species, but if so he was confused in concept of its range and that of *C. porosus*.

Another whole chapter was devoted to the "goana" (*Varanus*, any of several species), but virtually everything in it was fabricated; only size (4 to 5 ft.) was reasonable, whereas descriptions of size of snakes were almost invariably excessive.

Snakes enter into six chapters, but form the entire subject of but one (pp. 247-251); in others their role is minor (e.g., p. 67), incidental (e.g., pp. 152-153) or importantly integral to the story (pp. 238, 278, 302-304). In every case the story is largely or wholly fictitious. Only one was repeated in the books specifically on snakes.

The first three books by Sundowner, including "Snakes" as the earliest, were published by European Mail; the 2nd and 3rd of that series end with numerous pages of miscellaneous advertisements, including several pages of quotations of reviews of "Snakes" and, in the 1897 book, also of the 1896

"Noqu Talanoa." No such excerpts from reviews appear in the last two books, published by Chatto & Windus.

The excerpts from the reviews of "Snakes" are fascinating. All refer to it as the "Second Edition," presumably differing from the first by inclusion of the publication date 1895, and by having the preface bound properly. We have not found a copy of the second edition; the two that we assume represent the second edition, since they apparently bear an imprinted date of 1895, in Field Museum of Natural History and McGill University, have been lost, and no others are known to us. Certainly the first edition is represented by a copy in the British Library; it lacks a table of contents and an imprinted date of publication, and has the preface bound after p. 16. A copy in the National Library of Australia may represent the second edition, or may not; it lacks a publication data, like the British Library copy, although the date 1896 is entered on the title page in pencil. Unlike the British Library copy, however, "the preface is placed between the title page and list of contents" (Dr. I. Kears, pers. comm.). Thus the differences between and actual dates of publication of the purported two editions remain enigmatic, and await determination by comparison of additional copies. Unfortunately only two can be located at present anywhere in the world. It is likely, however, that the second edition, whether so indicated or not, followed hard on the heels of the first, much as in the case of Noqu Talanoa, with a minimum of printing changes.

In any event, an astonishing 34 different reviews, in 32 journals, are claimed in the 1896 and 1897 books to have been excerpted about "Snakes." Included is one brief complimentary comment from a letter to the author by "Professor Stradling, the well-known ophiologist" (not known at all to us, nor to British Museum herpetological authorities, fide Mr. A. F. Stimson, pers. comm.). The journals are of remarkable diversity: (1) African Review, (2) Antigua Standard, (3) Christian Age, (4) Daily Chronicle, (5) Daily News, (6) Devon and Exeter Gazette (2 reviews), (7) Dominica Guardian, (8) Eastern Morning News, (9) Edinburgh Evening News, (10) Financial News, (11) Gall's Newsletter, (12) Glasgow Herald, (13) Imperial and Asiatic Quarterly Review, (14) Introduction, (15) Jamaica Post, (16) Lancaster Standard, (17) Marmion, (18) Morning Advertiser, (19) Overland Mail, (20) Public Opinion, (21) Publisher's Circular, (22) Scotsman, (23) Sheffield Daily Telegraph, (24) Sheffield Weekly Telegraph, (25) Shipping, (26) South Africa, (27) South African Empire, (28) South American Journal, (29) South London Observer, (30) Weekly Irish Times, (31) Western Mail (Cardiff), and (32) Westminster Gazette.

One has to be impressed with such a wide reception, certainly matched by few if any books in modern times, at least as reflected by number of reviews. Strangely, however, only fourteen (nos. 1, 3, 5, 13, 14, 17, 20, 21, 22, 25, 26, 27, 28, 32) of these 32 journals are listed in the exhaustively complete British Union Catalogue of Periodicals and Union List of Serials, at least for dates compatible with Sundowner's books. Hence all of the review excerpts, as well as "Professor Stradling's" comment, have to be suspect, unfortunately, however cogently or amusingly written, as indeed many of them are. We have not searched any of the cited journals, however, for the review purportedly occurring in them.

Since Sundowner's "Snakes" is contained in its entirety in his last book, "The Tale of the Serpent," attention may be focused upon the latter work, which contains a great deal more than the first. In both books his avowed, explicit purposes were to debunk erroneous beliefs about snakes, and to foster tolerance of them. No naturalist would fault these objectives, and in so striving Sundowner was certainly one of the earliest writers to attempt on a large scale (two books) to educate the public in general, in the English language, in these contexts.

To quote from the Preface of "Snakes," Sundowner explains that "so many unreliable and obviously fanciful accounts of snakes and their habits are printed from time to time...that the author has been moved to put the following veracious chronicle of his own experiences among reptiles before the public. Snake stories, owing in great measure to the laches of newspaper editors in admitting to their columns apocryphal yarns about snakes, have come to be regarded as somewhat on a level with ghost stories, and it is high time that some man of good character and reliability - as well as of experience among snakes - should come forward and throw the limelight of truth upon what is to many an interesting subject."

Much the same theme was expounded at greater length in the introductory chapter (of seven pages) of the 1902 book. Extrapolating from erudite quotations from Pepys, Richard Owen and the Bible, Sundowner argued that "...the snake is not to be despised;...its poisonous qualities...have been greatly exaggerated.... A snake is no more vicious than a dog; he will never bite you unless you knock him about, or tread on his tail, and when you have him as a pet and he has become really attached to you he will put up with any amount of teasing or even maltreatment before he thinks of turning his fangs on you.

"No; we may boast...about our humanity and our sympathetic consideration of dumb creatures, but if we come to examine our consciences closely we must admit that we are humbugs after all, to a great extent....

"Say or do what we like, human nature is strongly impregnated with brutality. Education, the inculcation of Christianity, the study of poetry, the preaching of homilies on gentle behavior - none of these influences has yet effected anything material in the way of toning down the inherent coarseness of our systems.... To me this seems all wrong and unnatural, and I believe it will seem so to you if you will only sit down somewhere and think the thing out.

"...I have lived among snakes, and claim to know something about them, having, in a way, shared their joys and their sorrows with them. If...by writing...[this book] I may, in ever so slight a degree, bring the public mind round towards a more kindly view of snakes, I feel that I shall not have laboured in vain.

"As to the newspapers, I live in the hope that the conductors of these great fabricators of public opinion may yet find grace, and sweep from their minds the prejudice against the serpent family, which is as hurtful to their

own high intelligence as it is to the interests of these humble creeping creatures."

Fortified by these quaintly stated but laudatory objectives, the reader is prepared for a thoroughly satisfying, sympathetic and rigorously factual tour through the complexities of ophidian natural history, at least as known by Sundowner.

Instead one is treated to the most preposterous, absurd, ridiculous, extravagant exaggeration and falsification that has ever been written on the subject of snakes. To a certain extent the message of sympathy and good will toward snakes comes across despite the wild abandonment of fact, but far from dispelling the myths that abound in popular snake lore, Sundowner augmented them unconscionably. So ridiculous are many tales he recounts that they might be regarded as laughable, but so solemnly are they stated as fact, clarifying long-nurtured public misconceptions, that one must be grateful that both books are so rare as to be inaccessible for the general public. Sundowner merely exercised his rare talent for spinning captivating yarns, and the kindest view of them is that at least little cruelty per se comes through.

For good reason, then, none of the several works on Australian herpetology, or on that of other South Pacific areas, have mentioned Sundowner's extensive treatment of snake lore of those regions. Even now, it is well that the rarity of Sundowner's books on snakes will perforce let sleeping dogs lie.

For the sake of providing assurance that the perennial state of neglect into which the books have fallen may be construed as fully justified, a few examples may be cited.

The fable of swallowing of the young was repeatedly recounted in various guises (chapters 1, 10, 14), elaborated with click-like signals from the mother snake, causing the young to flock to her open mouth and to crawl into her stomach; another click advises the young that the coast is clear, whereupon they emerge again to roam around the vicinity. On occasion young other than her own hasten down her throat upon hearing the warning signal, leaving no room for the last of her own, which have to be abandoned, becoming "orphans" which have a hard time learning snake ways, having no one to teach them.

Sundowner made much of the necessity of young snakes to learn from their mothers how to crawl and to capture and swallow food, avoid enemies and follow the seasonal cycles of their kind. He noted that some individuals and kinds learn quickly, others not. Some learn to mesmerize birds, bringing them into their striking range, although they can be fooled into exerting their full powers on artificial birds, and they occasionally "charm" into reach birds much too large even to attempt to eat; these they simply release. "Black snakes" were best at charming, but "green snakes" and "whip snakes" were unable to do so.

Making much of the learning ability of snakes, Sundowner repeatedly described pet snakes that had the run of the house and yard or the entire ranch ("station," as termed in Australia). They would come when called and developed deep affection for the family. They made great retrievers. Not satisfied with that, Sundowner made snakes so popular in demand that snake farms were developed; he ran several from one time to another. Also, snakes were nurtured as fighters and meets were held all over, pitting one snake against another much as in cock-fighting.

Another proclivity of Sundowner's snakes was a passion for music, to which they would often dance. They expressed pleasure by wriggling and by waving or snapping the tail like a whip. For food they loved flies above all, snapping at them in all directions, and were easily lured by them, although they would also eat eggs, birds, mammals and, nothing else available, some big constrictors would eat fruits of various sorts. Hoop snakes couldn't "charm" anything, so ate mushrooms only. Any object of modest size or larger would be "slimed" before swallowing. Milk was a primary food and would serve as a lure. Snakes milked cows, of course, if not provided with milk otherwise.

Many of his snakes loved to have a tail in their mouth, serving often as a soporific. Thus hoop snakes were a natural expectation, racing across the countryside faster than a horse could run. And several kinds that loved bird eggs would form a living chain, mouth of one snake grasping tail of the next, extending down a precipice so they could rob the nests of cliff-dwelling birds. Garter and ribbon snakes were exploited, because of their tail-biting proclivity, as live garters by women; they were laterally compressed, hence had to sun themselves on one side, then the other. Their skins were used as hair ribbons by young girls.

Size was of course a prime focal point for attention, from 6-in. "deaf adders" to 40-50 ft. constrictors in New Guinea, and 85-ft. sea serpents. "Black snakes" were commonplace up to 12 ft., "carpet snakes" up to 14 ft., in Australia, "cannibal" snakes up to 20 ft., "diamond snakes" to 25 ft. (Cogger, 1979, records 2.5 m as the maximum for caenophidians [= colubroids] in Australia, reached by *Parademansia microlepidota*, the Fierce snake. Several booids exceed that limit, *Liasis amethystinus*, the Amethystine python, being the largest, at 8.5 m.)

Eyelids were several times indicated as being present and closed when snakes slept, blinked from time to time while awake. The venomous kinds could protrude their fangs threateningly, snap at intruders, and spring back on the tail. They sweated profusely when exerting themselves to the maximum. Their moulted sloughs were equated with skins themselves, and could be tanned for use as belts, etc. Their eggs were brooded, mostly by the females, who had to be present when the eggs hatched, to teach the neonates how to survive; hence snakes farmers could not successfully populate their farms with snakes by incubating eggs taken from their parents, for the young would have no one to teach them.

The sea snakes of northern Australia occurred long distances upstream in the rivers of the region, and made swimming suicide there, for humans. They were, however, so addicted to flies for food that they could be lured away from favorite swimming holes, although never with artificial flies. They laid their eggs in nests in stream banks, where they were brooded much like other snakes did.

In parts of Australia live snakes were so treasured that they were used as common currency.

Sundowner contrasted Indian and New Guinea constrictors, noting that the former were strictly terrestrial and would never enter water unless milk was in it, whereas the New Guinea constrictors were highly aquatic. Although large enough to eat the native humans of the island, they would never do so unless they were thoroughly washed.

Sundowner crossed various species of sea and land serpents on one of his snake farms, but found them too intractable to be a financial success. He even imported "grass snakes" and "adders" from England for his breeding experiments. The adders interbred successfully with Australian species but the hybrids were deaf and hence of no value. The grass snakes wouldn't cross, on the contrary, although they were great pets. He recommended crossing the pigmy rattlesnake of Florida with the English adder as a likely source for valuable hybrids, although he never had the opportunity to do so.

One amazing discovery was that snake societies exist in every species, each with its hierarchy of government officials, including judges who determine responsibility in wrong-doing and meting proper punishment, with the king as the last court of authority and the main overseer of the health and welfare of his subjects.

Rope was recommended as a barrier to snakes around a camp, and indeed Sundowner claimed responsibility for introduction of that valuable practice to North Americans.

With only "over 100" species of snakes in Australia (Cogger, 1979, lists 143), shooting of them was banned in Sundowner's time, as a conservation measure.

Snakebite treatment was noted incidentally in two accounts, and included use of "laudanum" (opium), brandy, rum, other "decoctions," puncturing the wound, sucking it and burning it "with red-hot coals," and not allowing the victim to sleep until medical attention was received.

Among reptiles other than snakes that graced the continent of Australia, the "griffin" was the strangest. The animals were about four ft. long, with a wing spread at that size of seven ft., five and one-quarter in. The wings were in addition to the four limbs. Griffins were trained with great success as messengers.

Repeatedly Sundowner exhorted his readers to give snakes "kindness and confidence," in return for their everlasting friendship and devotion. He also strongly advocated establishment of a Society for the Prevention of Cruelty to Snakes.

Predominant in Sundowner's writings is the penchant for the spinning of a yarn, whether true or fictional. Certainly his snake stories are wildly imaginative and extensively unrealistic. Taken frankly as exercises in exaggeration, they succeed very well; one can hardly fail to be amused by their preposterousness. Yet the repeated insistence upon intent to straighten the record for these wildly misunderstood animals exacerbates rather than ameliorates the fears and misconceptions of the unsuspecting reader. The seemingly real sympathy for snakes and desire to protect them -- possibly, although improbably, Sundowner's ultimate aims -- are largely nullified whether the reader correctly interprets the tales as purely entertaining fiction or incorrectly accepts them as gospel. Some of the purported, quoted reviews exemplified each extreme. The only actual review we have seen, of the 1902 book, was appropriately caustic, in part reading: "The short story is rather a trying medium for [that] writer who, in the literary and artistic sense, is ill equipped. [His] false strokes are as glaring in the short story as a painter's blunders would be in a miniature. The present volume consists of five-and-thirty short, slangily written sketches, in each of which a snake appears. In the beginning the unsuspecting reader is deluded into the belief that he has come upon the work of a real lover of snakes, and looks forward to the perusal of pages of series interest. Later, he discovers that the fare offered him consists only of a bundle of "snake yarns" such as one finds every now and again in country newspapers. Australian newspapers particularly are full of such narratives during the silly season.... "The Tale of the Serpent"...does contain a good many sketches which the gentry who glibly "swap yarns" in railway carriages would condemn as "chestnuts," and poor at that." (The Athenaeum, London, no. 3890, May 17, 1902, p. 622.)

Yet Sundowner's books may well be the first and perhaps the only attempt by a single author to create an exhaustive collection of snake lies. Perhaps the closest approach to Sundowner's historic compilation is Dobie's (1965) collection of tales about rattlesnakes, but the latter was gleaned from many sources and is far more restricted in subject matter than Sundowner's 1902 book. The two books are similar, however, in being wildly imaginative and presented with solemn assurance of veracity. Both are extrapolations, however far-fetched, from reality; they are not so completely flights of imagination as the several classical Greco-Roman fables about snakes, or snakelike animals, that have been preserved to the present time, or as Masefield's nightmarish sea snake in "Port of Many Ships" (Masefield, 1916: 9-10).

Any herpetologist encountering Sundowner's books on snakes would promptly recognize them as mendacious, although the only one of whom we are aware having perused them is the famed C.J.P. Ionides, about whom Alan Wykes wrote (1960). Mr. Wykes kindly searched his notes taken while interviewing Ionides in Africa, and found the comment by the noted snake collector:

"...that New Zealand mountebank Tichborne...a real Munchausen..." (pers. comm.).

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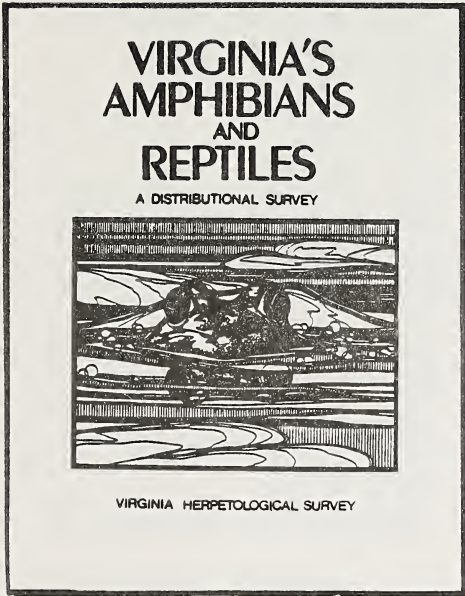
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FACT SHEET

EARTHWATCH is a tax-exempt, nonprofit institution first incorporated in November of 1970. The organization is a public charity under sections 501(c)3 and 509(a)2 of the Internal Revenue Code for its charitable, educational and scientific activities (Federal #237168440).

EARTHWATCH provides volunteers, funds and recognition to research scholars in the sciences and the humanities. Since 1971, the organization has sponsored 690 expeditions in 68 countries. To date, over 13,000 volunteers have contributed over \$7 million to the search for solutions to important problems around the world.

The following characteristics describe EARTHWATCH today:

- Headquartered at Habitat, a nature preserve at 10 Juniper Road Belmont, Massachusetts, the organization has field offices in Los Angeles, Dallas, Washington, D.C., London and Sydney, Australia.
- EARTHWATCH is represented by volunteer Field Representatives in 49 cities.
- 2,200 volunteers are expected to join research teams in 1985, up from 1,750 volunteers in 1984. Age range is from 16 to 65.
- Volunteers come from every state in the United States, and about 12 other countries each year.
- In 1985, EARTHWATCH will sponsor 90 expeditions in 16 states and 36 countries. Projects are divided into over 400 two to three-week long teams to enable members of the public to join.
- The organization publishes 4 newsletters and 4 magazines (ISSN 8750-0183) each year describing the work in progress and research findings.
- EARTHWATCH's affiliate, The Center for Field Research, receives over 300 proposals a year from scholars who need the help of volunteers. The Center, with its academic advisory board, is responsible for peer review, screening and selection of projects for EARTHWATCH support.

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Animal Behavior	8	Marine Archaeology	1
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- EARTHWATCH has over 16,000 members in the U.S. and over 500 in Australia. Its members include students (20%), educators (20%) business and professional people (45%), and retirees (15%).
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- 45 percent of current projects are renewals. The largest project has had over 450 volunteers in ten years of EARTHWATCH support.
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- Headquarters staff in Belmont numbers 39, with 8 individuals staffing field offices in four locations.
- The organization's president is Brian A. Rosborough. Senior Vice President is Jennifer Froistad. One of the Founding Directors is Dr. Harold Edgerton, Professor Emeritus of MIT, founder of E046, and inventor of strobe photography.
- Membership in EARTHWATCH is \$25 per year. The organization welcomes larger contributions at the following levels: \$50 Sponsor; \$100 Donor; \$500 Backer; \$1000 Patron and \$5000 Angel. All contributions are tax-deductible.
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3/22/85

FIRST INTERNATIONAL SYMPOSIUM ON KEMP'S RIDLEY SEA TURTLE BIOLOGY, CONSERVATION AND MANAGEMENT

Texas A&M University, Mitchell Campus, Galveston, Texas, 1-4 October 1985
Sponsored by the National Marine Fisheries Service, Southeast Fisheries Center,
Galveston Laboratory and Texas A&M University at Galveston

PURPOSE

Kemp's ridley sea turtle (*Lepidochelys kempi*) has received increasing attention from government and university researchers concerned with the development and implementation of sea turtle conservation and management. An international symposium will convene these researchers, sea turtle experts and representatives of private organizations to review the status, knowledge and on-going research on biology, conservation and management of Kemp's ridley sea turtle. The symposium will provide resource managers, researchers, students, conservationists and the public an opportunity to share information on Kemp's ridley sea turtle and to discuss effective strategies for conservation and management of this critically endangered species.

PROGRAM

The symposium will include invited papers and a panel discussion to report new findings, approaches and methodologies, to review and summarize existing information and to discuss current and future issues and opportunities. Nine technical sessions will be convened. Session topics include:

- Historical Perspectives, Trends and Opportunities in Kemp's Ridley Sea Turtle Conservation and Management
- Status of Kemp's Ridley Sea Turtle Population
- Public and Private Participation in Kemp's Ridley Sea Turtle Conservation
- Hazards, Strandings and Rehabilitation of Kemp's Ridley Sea Turtle
- Kemp's Ridley Sea Turtle Head Start Research
- Tagging, Tracking and Distribution of Kemp's Ridley Sea Turtle
- Kemp's Ridley Sea Turtle Data Base Management
- Biological Investigations and Captive Breeding of Kemp's Ridley Sea Turtle
- The Future for Kemp's Ridley Sea Turtle: A Panel Discussion

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SYMPOSIUM REGISTRATION

Registration fee for the symposium includes program, abstracts and a copy of the printed proceedings.

Pre-registration Fee (Prior to 1 September 1985)	\$25.00
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HOUSING ACCOMMODATIONS

A small block of rooms has been reserved at reduced rates in the Texas A&M University dormitories on Pelican Island. This housing is limited and reservations will be taken on a first-come first-serve basis. Cost for dormitory housing will be \$12.50/person/night for double occupancy. It may exceed \$12.50/person/night for single occupancy. Towels and linens must be provided by occupants. Participants wanting dormitory housing should contact Dr. Andre M. Landry prior to 1 September 1985. A listing of hotel accommodations available on Galveston Island is enclosed. These accommodations are the responsibility of each participant.

ADVANCE REGISTRATION FORM

(You may register at the symposium)
Detach and mail before 1 September 1985 to:
Dr. Andre M. Landry, Jr.
Department of Marine Biology
Texas A&M University at Galveston
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Check or money order must be in U.S. currency (foreign currency is not acceptable) made payable to: *Kemp's Ridley Sea Turtle Symposium*

NEWS/FACTS ON FILE®

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VIRTUOSO PHOTOGRAPHER CAPTURES NATURE ON THE WING IN NEW BOOK FROM FACTS ON FILE

* "If any photographer is able, in a still picture, to convey
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-- Konrad Z. Lorenz

World-renowned wildlife photographer Eric Hosking takes all nature lovers on a shimmeringly vibrant tour through one of nature's most fascinating realms in a magnificent new book, *WILDFOWL*, photographs by Eric Hosking, text by Janet Kear, foreword by Konrad Z. Lorenz (Publication date: April 30, 1985; Price: \$24.95, hardbound).

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In 145 beautiful photographs, including 120 in full color, Hosking captures the movement and activity of these fascinating creatures in their surroundings -- in both characteristic and uncharacteristic moments.

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A visually splendid panorama of nature on the wing, *WILDFOWL* will appeal to bird enthusiasts, nature lovers and photography buffs alike.

ERIC HOSKING was awarded the OBE by Her Majesty the Queen in 1977 for his natural history photography and work in conservation. He is co-author of many books including *Birds in Action*, *An Eye for a Bird*, *Antarctic Wildlife* and *Eric Hosking's Seabirds*.

DR. JANET KEAR is Assistant Director of the Wildfowl Trust and Curator of Martin Mere, Lancashire. She edited *Flamingos*, was co-author of *The Hawaiian Goose* and is also editor of the British journal *Ibis*.

WILDFOWL, photographs by Eric Hosking, text by Dr. Janet Kear, foreword by Konrad Z. Lorenz; Publication date: April 30, 1985; Price: \$24.95, hardbound; 154 pp.; 8 1/2 x 10 3/4; ISBN: 0-8160-1152-4 Index. Over 145 photographs with 120 in full-color
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All correspondence should be addressed to the Executive Editor. Manuscripts being submitted for publication should be typewritten (double spaced) on good quality 8½ x 11 inch paper, with adequate margins. Submit original and first carbon, retaining the second carbon. Indicate where illustrations or photographs are to appear in text. Cite all literature used at end in alphabetical order by author.

Major papers are those over 5 pages (double spaced, elite type) and must include an abstract. The authors name should be centered under the title, and the address is to follow the Literature Cited. Minor papers are those papers with fewer than 5 pages. Author's name is to be placed at end of paper (see recent issue). For additional information see *Style Manual for Biological Journals* (1964), American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016. Price is \$6.00.

Reprints are available at \$.03 a page and should be ordered when manuscripts are submitted or when proofs are returned. Minimum order is 100 reprints. Either edited manuscript or proof will be returned to author for approval or correction. The author will be responsible for all corrections to proof, and must return proof preferably within 7 days.

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DEPARTMENT OF HERPETOLOGY

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The Maryland Herpetological Society
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Meetings

The third Wednesday of each month, 8:15 p.m. at the Natural History Society of Maryland (except May-August, third Saturday of each month, 8:00 a.m.). The Department of Herpetology meets informally on all other Wednesday evenings at the NHSM at 8:00 p.m.

A NEW SUBSPECIES OF ARBOREAL LIZARD, GENUS *Laemanctus*,
FROM THE MOUNTAINOUS REGION OF LOS TUXTLAS, VERACRUZ,
MEXICO (LACERTILIA, IGUANIDAE)

Gonzalo Pérez-Higareda and Richard C. Vogt

Abstract

A new subspecies of *Laemanctus serratus* is described from the higher elevations of the Los Tuxtlas region of southern Veracruz, occupying an area between the recorded ranges of *L. s. serratus* and *L. s. alticoronatus*.

McCoy (1968) considered the species *Laemanctus serratus* Cope and *L. alticoronatus* Cope as subspecies of *L. serratus*, distinguishing them as follows: in *L. s. serratus*, body scales smaller ($\bar{x} = 59$ at mid-body), casque scales smaller ($\bar{x} = 22,3$), subdigital lamellae of 4th toe more numerous (\bar{x} = more than 75), and an azygous scale usually present (72%) among the enlarged anterior dorsal head scales; and in *L. s. alticoronatus*, body scales larger ($\bar{x} = 53$ at mid-body), casque scales larger ($\bar{x} = 21$), subdigital lamellae of 4th toe less numerous ($\bar{x} = 73.6$, less than 74), and an azygous scale less frequently present (26%). In the same work, McCoy recorded *L. s. serratus* from Tamaulipas and San Luis Potosí south into northern and central Veracruz (in the Misantla, Xalapa, Orizaba and Boca del Río regions), penetrating south perhaps to some regions of Oaxaca and Chiapas, and *L. s. alticoronatus* from the Yucatán peninsula and Campeche. At the time of that revision, no specimens were known from southern Veracruz and Tabasco. Our data are based on the examination of twenty-six specimens (10 adults and 16 juveniles and hatchlings) collected at El Acuyal, 10 km NW Catemaco, Veracruz, on the isolated peaks named Cerro Chochobí and Cerro Egega, at 900 and 1000 m above sea level.

McCoy's (op.cit.) casque scale count was made from the last supraciliary on one side to the last supraciliary on the other, and that of the lamellae was the sum of the number on the two sides (McCoy, pers. comm.). Using this system, the specimens from El Acuyal exhibit characteristics at variance from the subspecies *serratus* and *alticoronatus* as well as from the two specimens known from Chiapas and the one from northern Veracruz (Cerro Azul). The differences occur in size of the scales around mid-body, number of scales around both casque and body, and number of lamellae on the 4th toe of the hind feet. These important taxonomic characters, correlated with geographic isolation and differences in habitat, lead us to conclude that the form found at these elevations of the region of Los Tuxtlas is a distinct subspecies of the *serratus* group:

Laemanctus serratus mccoysi subsp. nov.

Holotype. Adult male (UNAM-LT 1326) from El Acuyal, municipality of Catemaco, Veracruz, México, 10 October 1981, collected by GPH.

Paratypes. Four adult males, five adult females and 16 hatchlings and juveniles (UNAM-LT 1312-1328, 1670, 1744-1751) from the same locality, February 1981, same collector. All specimens are in the collection of herpetology at the Estación de Biología Tropical "Los Tuxtlas", Universidad Nacional Autónoma de México.

Diagnosis. This form has both large and medium body scales (beginning at the lateral white stripe and up to the 15th or 16th scale row they are small; beyond the 16th row the dorsal scales as well as the ventrals are larger), and is characterized by mean scale counts of 51.3 around mid-body, 19.5 around casque, 66 4th toe subdigital lamellae; usually three pairs of enlarged postrostrals; only 25%, including the hatchlings, have an azygous scale among the enlarged anterior head scales; dorsal crest with scales well developed in adult males, crest incomplete in adult females. See Table 1.

Table 1. Means and ranges of scale counts in the subspecies of *Laemanctus serratus*, based in part on data from McCoy (1968)

SCALES	<i>L. s. serratus</i> N	<i>L. s. alticoronatus</i> N	<i>L. s. mccoysi</i> subsp. nov. N
Around mid-body	50.8 (51-65) 32	53.4 (49-62) 51	51.3 (47-54) 26
Around casque	22.3 (19-24) 32	21.0 (18-25) 51	19.5 (14-21) 10 (adults)
Subdigital lamellae	76.0 (70-83) 32	73.6 (67-85) 51	66.0 (58-68) 26
Azygous scale	72% 39	24% 50	25% 26
Size on mid-body	smaller	larger	smaller and larger

Description of holotype. With 50 scales around mid-body; 19 casque scales; 32 dorsal crest scales; 66 4th toe subdigital lamellae; 3 pairs of enlarged postrostral scales and no azygous scale. Snout-vent length 105 mm; tail length 356 mm; head length 38 mm; gular fold not pronounced. Color as follows.

Coloration. In life the adult specimens differ in coloration from those mentioned by Alvarez del Toro (1972) from Chiapas. The dorsolateral and ventrolateral regions, as well as the lateral and nuchal areas on the head, are lemon-green; from base of neck a longitudinal mid-dorsal light brown streak extends onto the tail. A lateral stripe of the same color begins at the orbit, crosses the tympanum and continues dorsolaterally to the base of the tail, extending onto upper arm, thigh, and shank. Five dark brown transverse bands on the dorsal surface of body are visible only on the

light brown lines, and diffuse on the green areas of live specimens. Thus it appears as if the animal has three longitudinal series of dark brown squares. Those squares usually are eight scales in length in the mid-dorsal series. In some specimens the markings become wide bands or rings around the tail. From the inferior part of the orbit, between the brown streak and the supralabials, a white stripe extends across the angle of the jaws, continues onto the neck and ventrolateral surface of the body, reaching the base of the tail, interrupted in the axillary and inguinal regions. A small white spot is present on the anterior part of the body between the white ventrolateral stripe and the dorsolateral brown streak. There is another small white streak four scales in length on each side of the neck. Above the white supralabial line appears a dark brown line crossing the eyelid from the supraciliaries to the tympanum. Above and parallel to this, are other incomplete lines from the subocular region. The borders of the supralabials are black spotted. The top of the head is gray in females and brown in males, with only a small frontal area remaining green. The iris is orange. In life the shades of colors vary. The hatchlings are yellow with dorsal brown blotches, the top of the head gray.

Distribution. The only known locality for this subspecies is the hill zone of El Acuyal, 900 to 1000 m above sea level. It likely occurs throughout the higher elevations in the region of Los Tuxtlas, where the same ecological conditions exist. It also may range southward into Tabasco, although presumably at high levels in forested regions to which habitat it appears to be restricted; it does not appear to enter the lowlands, where it is replaced by *L. longipes*. There are no published reports of *L. serratus* from the lowlands of the region of Los Tuxtlas, or from southern Veracruz or Tabasco. Topographic and latitudinal phenomena influencing the Veracruzian herpetofauna, particularly many subspecies of reptiles, have been commented on by Pérez-Higareda and Navarro L. (1980). They proposed two faunistic districts for the northern and southern regions in the Veracruzian Biotic Province. Despite the fact that *L. s. serratus* has a broad distribution, it is found only in restricted geographic populations. The known populations of *L. s. serratus* are found principally in Tamaulipas, San Luis Potosí and northern Veracruz, as well as the Orizaba and the Xalapa regions, which are located in the North District and in the Sierra Madre Oriental, respectively. The subspecies *L. s. alticoronatus* inhabits the Yucatán peninsula and Campeche, whereas the only known locality for *L. s. mccoysi* is in the South Faunistic District, and more precisely the Catemacan Faunistic District, as proposed by Firschein and Smith (1956) (see map). Intergradation in the mountainous region of Los Tuxtlas is unlikely because there is no continuity in the distribution of the two established subspecies. The mountains of Los Tuxtlas are isolated within a wide coastal plain and in them numerous other isolated populations have evolved subspecific differences, as for example *Xenosaurus g. sanmartinensis*.

Etymology. The subspecies is named in honor of Dr. Clarence J. McCoy, in recognition of his work with systematics of Mexican lizards, in particular the revision of this genus. The name is a noun in the genitive case.

Figure 1.



Ecological data. All specimens of *L. s. mccoysi* were collected at elevations between 900 and 1000 m above sea level, within humid forest with fog and high rainfall (more than 4000 mm annually). This habitat differs from the described habitats for the other subspecies of the *serratus* group. McCoy (loc.cit.) mentioned drier forest types with annual rainfall under 2000 mm and a long dry season; Martin (1958) collected specimens of *serratus* in the Gómez Farías Region in Tamaulipas, in tropical deciduous forests; and Fitch (1970) states the habitat as lowland forests. The zone El Acuyal is situated between Mario Souza and Catemaco and consists of different elevations from 650 to 850 m above sea level, all perturbed by man with large clearings of secondary growth surrounding several isolated and steep peaks of virgin rain forest, with elevations of 900, 1000, and 1200 m above sea level. These peaks or islands of rain forest are similar to the vegetation type of Los Tuxtlas mountains of higher elevations (see Gómez-Pompa, 1980). The vegetation and fauna are much different from those of the plains or lowlands.

Remarks. The adult and immature specimens were collected in January and February (the coldest season, 16–18°C), on shrubs, approximately in 1–2 m in height above the forest floor, hidden among the foliage where they were difficult to observe. Eggs are laid under surface debris in open areas in the nearby forest. Four nests were found in May and June; one nest contained five eggs, and three contained seven eggs each. All were incubated under laboratory conditions at ambient temperature (26–28°C), and hatched during August and September. The hatchlings were 40 mm in snout-vent length and 80 mm in tail length (mean). Hatchlings were maintained live for growth observations, but only one survived eight months. It is important to note that, even though their diet is largely of insects and snails, they also feed on small lizards of the genus *Anolis* (Martin, 1958), and a small frog (genus *Eleutherodactylus*) was found in the stomach contents of one adult.

The scale counts of *L. s. mccoysi* suggest a closer relationship to the Yucatán subspecies *L. s. alticoronatus* than to the mainland subspecies *L. s. serratus*.

Acknowledgments

We thank Dr. Hobart M. Smith, Dr. Clarence J. McCoy, Professor Miguel Alvarez del Toro, and Dr. Gustavo Casas A. for their counsel, and Sr. Silvio Sánchez G. for aid in the field.

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SPATIAL ORIENTATION BY COTTONMOUTHS
(*Agkistrodon piscivorus*) AFTER DETECTING PREY

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Abstract

Six adult specimens of *Agkistrodon piscivorus* were briefly (10 sec) presented with prey held out of striking range. All snakes oriented toward prey and maintained this orientation long after prey were removed (15 min), even though no chemical cues were deposited into the snakes' cages during the initial presentations. When a chemical trail is available (e.g., under natural conditions) this behavior could increase the probability that snakes encounter it.

Prairie rattlesnakes (*Crotalus viridis*) oriented toward mice suspended for 10 sec into their cages, and the snakes maintained this orientation for 20 min after prey were removed, even though no chemical cues had been deposited by rodents during the initial presentations (Kandler & Chiszar, 1986); see also Chiszar et al., 1983; Gillingham & Clark, 1981). Such spatial orientation could facilitate relocation of prey under natural conditions (i.e., where a chemical trail would be deposited by departed prey) because attending to the place last occupied by prey would probably bring the predator into contact with the trail (Buning, 1983; Duillemeijer, 1961; Golan et al., 1982; Reinert et al., 1984; see Burghardt, 1970, for a review of chemical cue utilization by reptiles). The present experiment was designed to study spatial orientation of cottonmouths (*Agkistrodon piscivorus*) under conditions analogous to those in which rattlesnakes were studied. Although differences exist between the predatory behaviors of rattlesnakes and cottonmouths (Chiszar et al., 1986), the available data suggest that the taxa should exhibit similar spatial orientation following brief presentation of prey (Chiszar et al., 1985; Kardong, 1982; Wharton, 1969).

Materials and Methods

Six adult *A. piscivorus* (50-90 cm, S-V) were observed. These snakes had been fed a mixed diet of fish (15%), rodents (80%) and birds (5%) for about four years prior to this study. One or two live prey were offered to each snake every other week. Although the cottonmouths were used in several previous experiments involving chemical cues (e.g., Chiszar et al., 1985), no surgical or pharmacological manipulations had been performed. Hence, these animals were probably typical or long-term captive specimens of this species (Stabler, 1951). The snakes were maintained individually in glass cages (50 x 27.5 x 30 cm) containing paper floor coverings and large stainless steel vessels half-filled with water. Laboratory temperature was 26 \pm 1 $^{\circ}$ C during photophase (0700-1900) and 23 \pm 1 $^{\circ}$ C at night.

The test chamber (244 x 61 x 61 cm) had pea gravel (10 cm maximum depth) covering half the floor and water (10 cm maximum depth) covering the other half. At the interface the gravel sloped gradually into the water so that water depth increased from 0 to 10 cm over a distance of 122 cm. The floor of this apparatus was divided into 8 rectangles (61 x 30.5 cm), 2 of which were covered with 10 cm of water (right side), 2 of which were covered with 10 cm of gravel (left side) and the remaining 4 constituted the interface area. A snake was placed into the apparatus and remained there continuously for 14 days prior to tests involving prey. During this period we made an average of 20 5-min observations, recording tongue flicks and the location of the snake's head with reference to the rectangles described above. If the snake moved during an observation, we recorded the rectangles through which the head traveled as well as the amount of time spent in each rectangle. These observations were made on a random schedule.

A test began by suspending either a fish (*Lepomis macrochirus* or *Ictalurus nebulosus*, about 10 cm total length) or a mouse (*Mus musculus*, about 6 cm body length) from forceps into the center of the apparatus above the interface area for 10 sec. The prey was held out of striking range and was not permitted to touch the substrate or the walls. Hence, chemical cues were not deposited. A third test presented empty forceps for 10 sec. All snakes received the three tests, but a different order of presentation was used for each snake. Inter-test interval was 48 hrs. Following removal of prey or forceps, the snake was observed for 15 min; all movements of the head and all tongue flicks were recorded.

Results

Table 1 shows the mean percent of time that snakes spent in the three sections of the apparatus (see columns 1, 2 and 3). Data from tests with fish and mice were pooled because the snakes behaved similarly in these conditions. During the baseline period (days 1-14) all sections of the apparatus were visited with relative frequencies not significantly different from chance expectation based on the proportion of the floor area actually occupied by the three sections. When snakes were disturbed with forceps, they moved out of the water. More important, after prey items were briefly presented the cottonmouths moved to the interface area where the prey were last observed. Consequently in the latter tests the snakes spent a significantly greater percent of time in the interface than would be predicted by chance.

More movements occurred following prey presentations than during baseline observations or after snakes were disturbed with empty forceps. The rate of tongue flicking was higher after disturbance with forceps than during baseline observations, but both of these rates were significantly lower than that seen after prey presentations.

Table 1

Mean percent of time spent in the three areas of the apparatus by 6 specimens of *Agkistrodon piscivorus*; mean number of rectangles traversed by the snake's heads; and mean number of tongue flicks

Condition	Mean % time on gravel	Mean % time in interface	Mean % time in water	Mean Number of rectangles traversed (per min)	Mean Number of tongue flicks (per min)
Chance expectation based on floor area occupied by each section	25	50	25		
Baseline (days 1-14)	25.5	57.2	17.0	0.0 ^a	1.6 ^a
Test with forceps	33.3	64.9	1.7 ^{**}	0.2 ^a	4.3 ^b
Tests with prey	14.2	74.4 ^{**}	10.9	1.0 ^b	16.6 ^c

^{**}Significantly different from chance based on single-sample t test (p<.05)

Means within a column that have the same superscript do not differ significantly by paired t test.

Discussion

That cottonmouths moved out of deep water when they were disturbed with forceps may mean that the snakes were seeking places where defensive behaviors could be readily executed. Presumably the buoyancy or viscosity of water might interfere with these behaviors. Typically the snakes moved directly to gravel or to the shallow part of the interface and then either remained motionless or assumed a defensive posture with head and up and mouth agape.

The situation was quite different when prey were presented. The snakes not only moved toward the place where prey had been observed, but they also emitted many tongue flicks and swept their heads through most of the interface area. These behaviors occurred at a more-or-less constant rate during the 15-min observation period. That is, the snakes remained in the central area and made a systematic search of it, as if they were attempting to locate a chemical trail. Accordingly, it is concluded that cottonmouths, like rattlesnakes, maintained an orientation to the place where prey had been observed and aimed their searching activities in accordance with this orientation.

It is tempting to assert that the cottonmouths were orienting toward the vanishing bearing of the prey, but such a view is not warranted by these data. Because prey entered and departed by the same path, it is not possible to say which of these movements governed the snake's orientation. Indeed, it is possible that the critical factor was length of time that the prey remained stationary and detectable (Chiszar et al., 1983; Gillingham & Clark, 1981) rather than the directions through which it entered or departed. A decision between these alternatives would be permitted by an experiment that presented and removed prey through different compass directions with no stopping in between (or with systematically varied stopping times).

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THAMNOPHIS ELEGANS VAGRANS
(GRAY GARTER SNAKE), LONGEVITY

The greatest longevity record for *Thamnophis elegans* is reported in Bowler (1977) as 6 years, 1 month and 4 days.

An individual, ♀, was taken on a concrete entryway of a residence in the Montclair section of Denver, Colorado on 14 June 1957. It measured approximately 23 cm and was placed in an aquarium (15.5 liter capacity). A layer of washed gravel was provided together with a small tin for a retreat and a rectangular plastic container for water. Three "nightcrawlers" (*Lumbricus* sp.) were offered and were ingested. These worms were available until 19 November 1957 and thereafter a bait shop was the source of worms until Spring 1958. Only hybrid "Red Worms" (*foetida*) were rejected. Later, lean hamburger pellets placed in the snake's path were eaten.

The snake would drink only fresh, clean water. The water container was also utilized during the shedding of its skin. It would pass in and out of the water and in so doing, rub against the somewhat sharp edges. This activity apparently aided in the removal of the old skin.

By June 1969 the snake took no more food and it died on 2 August 1969. It measured 69 cm. On examination, the cloacal area had several layers of skin on and around it. It is possible that it died because excretion was impeded. This represents a longevity record of 12 years, 1 month and 17 days.

The specimen will be deposited in the herpetological collections of the University of Colorado Museum.

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ASPHALT AS A SNAKE TRAP AND A UNIQUE METHOD OF REMOVAL

Abstract

Numerous requests for snake identification in the last several months have brought together three similar cases involving asphalt entrapment. A novel method for asphalt removal without harm to the snake has been found.

On 29 August 1985, I was requested to confirm the identity of a "copperhead" snake stuck to a four-inch strip of Rubberized Asphalt Waterproofing Material in Howard County, Maryland. The snake, a 31-inch Eastern Hognose, *Heterodon p. platyrhinos*, was stuck to this 4-inch wide and about 3 feet long strip from the tip of the snout to the tip of its tail. The material is an asphalt base adhesive on a film in large sheets of which the backside has the four-inch strip to attach additional sheets. The material was being handled when a section was picked up containing the snake. It took about 10 minutes for me to remove the snake, inch by inch, leaving a few ventral epidermal scales in the asphalt material. I later released the snake and it appeared fine. Sand, etc., adhered to the small amounts of rubberized asphalt still remaining and locomotion seemed unaffected.

On 25 September 1985, I received a call that a "large" snake was stuck to some asphalt that had leaked from a drum on the concrete floor of a solvent shed at the same location. Fifteen feet from the site, the snake was identifiable as a *Boa constrictor*, based on color pattern probably of Central American origin, obviously an escaped pet. The snake measured about 6½ feet and was very heavy bodied, and was fully contained in an area of asphalt 4 x 5 feet and about ¾" deep. The asphalt was Lloydminster Asphalt and is basically a very heavy crude oil brought right out of the ground. The snake was stuck from the tip of its snout to the tip of its tail and, in addition, its sides were also covered. It took approximately 20 minutes to pull it free. It came loose without the epidermal loss that occurred with the rubberized asphalt base. The snake reared back to strike out and its head and neck stuck to the body as had its tail previously. When placed on the ground it stuck rigidly in place. Since it could not be released in this area, I had to find a way to remove the asphalt easily and safely. In places, the asphalt was about ¼" thick.

Arlene Chandlee, a laboratory worker, suggested the use of an oil to remove the asphalt, mentioning specifically a vegetable oil since it is generally considered non-toxic. The boa was placed in a large container of a 4-liter size which was "packed tight with snake" so about 1½ quarts of Mazola corn oil completely covered the snake. After about one hour the "black" asphalt oil was drained off and the procedure repeated. After the corn oil treatment was completed, paper towels were used to dry the snake and no asphalt traces could be found on its body. As of this note, the snake is doing fine. It did ingest some of the asphalt/corn oil mixture as it hid its head below the surface and when removed had material in its mouth.

On 9 October 1985, in this same patch of asphalt a 12" juvenile *Elaphe o. obsoleta* was found dead. It had actually entirely sunk and was flush with the surface of the asphalt. It appeared to have been dead about 2 days. Temperatures for the last several days have been mid to high 70's and low 80's(°F).

Comments

My guess is that the motion of the snakes' ventral scales is the main cause of entrapment, along with the temperature of the substance. In case one, the warehouse where it occurred was shaded and temperatures were in the 80's (°F) during the day. In cases two and three, entrapment occurred during the night as both were found early in the morning and temperatures during the night were in the 50-60°F range.

For those individuals wishing to assure themselves a snake-free house, asphalt might prove useful. A "moat" an inch thick and about four feet wide around their "castle" could prove an effective barrier for up to 6½-foot boa constrictors.

On a more positive note, corn oil or a vegetable oil has proven useful in removing heavy crude oil from snakes. Frank Groves of the Baltimore Zoo has successfully used glycerin to remove "tar" from turtles so brought into the Zoo. Depending on asphalt solubility in glycerin, glycerin would be a better choice since it can easily be removed by water washing, being miscible with water.

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NEWS AND NOTES:

A NEW ZOOLOGICAL LANDMARK

The year 1985 marks one of the most notable epochs in 20th century zoology: the appearance of the third, extensively revised edition of the International Code of Zoological Nomenclature (xx, 338 pp., London, International Trust for Zoological Nomenclature; obtainable from Publications Sale, British Museum (Natural History), Cromwell Road, London SW7 5BD, England, 15 pounds plus 1.50 pounds for postage and handling, or from the American Association for Zoological Nomenclature, Room W-115, National Museum of Natural History, Washington, D.C., \$21.50, postage and handling included).

Why epochal? Because, no matter how sophisticated, arcane or abstruse zoology has become and undoubtedly shall continue to develop, the basic prerequisite for all such work - far too often not realized or adequately appreciated - is knowing what organism is studied: its identity and its place in nature. Only on such knowledge should biology ever be pursued, now or in the future. That knowledge does not come automatically or effortlessly, as is too often seemingly assumed. Explicit attention is necessary, although a major input is not required; a single course of 2-3 hours' credit can do the job well in one semester. Evolution is widely and rightly recognized as the most fundamental, dynamically unifying concept of biology, as every student of which learns through several courses. Surely a comprehension of the entities and categories that are unified, and the basic procedures for handling their names to promote stability, universality and uniqueness, are as statically vital as understanding evolution is dynamically vital. To think otherwise would be like undertaking statistics without knowing how to add, subtract and multiply.

Thus this definitive edition of the Code is a vital component of the basic training and knowledge of every biologist; combined with instruction in the concepts of species and other taxonomic categories that are created in the course of evolution, the background exists for specialization in any of the many disciplines of biology. The two go hand in hand - taxonomic and nomenclatural understanding - and no biologist builds soundly without it.

In the present era, when extremely few biologists have a reasonable familiarity with simple nomenclatural procedures, and far too many have only vague and almost folklore understanding of species, genera and other taxonomic categories so vital to evolutionary processes, the potential role of the refined Code is indeed epochal. Every department of biology, at least at the university and college level, should assure that all of their students become properly and explicitly trained in both fundamental areas. Not only should the Articles themselves of the Code be studied, but also the very important preamble and the appendices, particularly the Code of Ethics, Name Formation (especially parts I - VI) and the General Recommendations.

Innovations

The basic form and scope of the first edition of the Code (1961; the second, 1964 edition made only a few, although important, changes) is maintained in the 1985 edition. It still leaves categories above the family-group level, and below the subspecies level, without controls - the latter because infrasubspecific populations are too ephemeral and numerous to merit nomenclatural recognition, and the former because zoologists are not sufficiently in agreement to permit promulgation of across-the-board rules. The 1985 objectives and the Official Lists and Indices remain the same, the terminology but little changed, and even the numbered articles approximately equivalent.

The 1985 changes are thus essentially improvements upon the earlier editions: innumerable clarifications, a much expanded glossary, an incorporation of the glossary as part of the Code, and a thorough index. Specific changes that stand out as especially noteworthy include the following:

1. In an attempt to counter interpretation of the Code as a "legal" document (with enforcement overtones), rather than a mutually accepted code of conduct and procedure (whose strength lies precisely in near-universal respect, and therefore in "peer pressure"), the "Laws" (of homonymy and priority) of earlier editions are replaced by "Principles," of Binominal Nomenclature, Coordination (i.e., pertinence at all ranks within each of the nomenclature groups - species, genus, family - of any and all names proposed at any rank within any one of those groups), First Reviser, Homonymy, Name-bearing Types, and Priority. It is an excellent change, broadening realistically a focus upon the major premises on which the Code is predicated.
2. The Principle of First Reviser (Art. 24) is much broadened and clarified; previously its pertinence was widely misinterpreted and even rejected because of uncertainty of application.
3. For the first time a parenthetic interpolation is permitted (Art. 6(b)) of specific or subspecific names to represent superspecies or supersubspecies (called exerges) respectively. For example, the "species aggregate," or superspecies, *torquatus* of *Sceloporus*, could be indicated in names of the members of that group as *S. (torquatus) torquatus*, *S. (torquatus) serrifer*, etc. Exerges or "subspecies aggregates" can be indicated in similar fashion, e.g., members of the *u. undulatus* subspecies group of *Sceloporus undulatus*: *S. u. (undulatus) undulatus*, *S. u. (undulatus) hyacinthinus*, etc. However, superspecies are not to be given new (Art. 11) or separate (Art. 10) names.
4. The earlier editions of the Code permitted erection of a neotype only if "all of the original type-material" had been lost or destroyed, whereas the same Article (75) of the new edition is concerned only with name-bearing type-material in this context; in other words, paratypes and paralectotypes have no preferred status in neotype selection.

5. The new edition of the Code makes it clear that only one lectotype can ever be designated from among a series of syntypes (Art. 74); the other syntypes thereupon become paralectotypes (Art. 73) and like paratypes have no special privileges as alternative name-bearers. Only a neotype can succeed a lost or destroyed holotype or lectotype, although neotypes can succeed each other.

6. If any specimen is explicitly designated as a paratype in an original description, and other specimens are noted but not explicitly designated as either the holotype or a paratype, those specimens are not to be considered as paratypes. The earlier editions were unclear on this point, and accordingly many authors assumed that any listed specimen, exclusive of the holotype, is a paratype whether so designated or not.

7. Paratypes and paralectotypes are left in the new edition with no even potential, official name-bearing role. Their value is therefore strictly zoological, never nomenclatural, unless a reviser wishes (and he need not) to designate one of them as a neotype.

8. A number of special accommodations to serve the particular needs of workers dealing with "Protozoa" is embodied in the new edition; most conspicuous is the novel concept of "hapantotype" (Art. 72, glossary) - one or more preparations (usually slides) containing any number of individuals, collectively serving as name-bearer.

9. The distinction between "type locality" and "statement of type locality" is made clear; the former is real, and the latter may or may not be erroneous. An erroneous statement should be replaced by a corrected statement (Art. 72).

10. The practice of designating "new combinations" as such (e.g., by the label "comb. nov." or "n. comb.," etc.) is widespread among taxonomists, many of whom regard any change from the original form of the name as a new combination. The new edition, however, limits the term to transfers of species-group names to any nominal genus other than the original; thus novel combinations of species-group names within the original genus (even in different subgenera) are not new combinations (so clarified by the glossary).

11. The nominate taxon of earlier editions is here termed the nominotypical taxon (e.g., *Sceloporus u. undulatus* of *S. undulatus*, Iguaninae of the Iguanidae, etc.) (see glossary).

12. The glossary finally lays to rest the specter of uncertain definition of hybrid, in the context of the Code, that has haunted taxonomists for decades, by explicitly limiting the term to progeny of parents of different species; progeny of parents of different subspecies of one species are not hybrids.

13. The proliferation in recent decades of different modes of duplication has introduced serious problems in clarifying what constitutes "publication." A noble effort is made in Arts. 8 and 9 to cover the

waterfronts, but to a considerable extent relies upon taxonomists to exercise good judgment (recommendations 8A and 8B).

14. Whatever uncertainties may exist otherwise about what constitutes publication, Art. 8b dictates that any work bearing a "disclaimer" - a statement that it is not "published" in the context of nomenclature - is to be rejected in that context. Not always in the past have such disclaimers been respected.

15. In the past, the adjective "nomenclatorial" and "nomenclatural" have been used more or less interchangeably by taxonomists. The Code now makes clear that the former refers to nomenclators as such, e.g., Neave's great Nomenclator zoologicus, and that "nomenclatural" refers to nomenclature. It is a useful distinction.

16. Definitions are given for the first time for "Directions" and "Opinions" of the Commission - the forms in which "rulings" are issued.

17. Equivalence of certain terms is made explicitly, e.g., "provisions" = "rules" = "articles," and "establish" = "make available."

18. For the first time, a list of scientific names cited as examples in the text is provided - an extremely useful reference.

19. The financial straits of the Commission are admitted without reservation, and a fully justified appeal is made inside the front cover for support, both individual and societal, for its invaluable and largely unrewarded, vital work.

Wish List

However epochal the third edition of the Code may be considered - and it unquestionably so merits - inevitably one may wish that still other questions, concepts or policies might have been incorporated in it. Some are suggested as follows:

1. Although the preamble to the Code makes plain that the object of the Code is to promote nomenclatural stability (reflecting constancy, universality and uniqueness), there is a surprisingly widespread misconception even among practicing taxonomists that priority is a law overriding virtually all other considerations. Such is not the case. Stability is the overriding consideration, to which the automatic provisions of the Code almost always contribute. When application of these provisions would upset well-established stability, appeal for exercise of the Plenary Powers of the Commission to maintain usage is to be made. The needs of zoologists as a whole are of primary importance; freedom to make name-changes irrespective of disturbance to zoologists in general is not a prerogative of taxonomists, no matter how easily they might adapt to those changes.

Therefore it would greatly strengthen implementation of the intent of the Code to add a Principle of Nomenclatural Stability to the six now recognized.

2. It is strange that the word "binomial" appears nowhere in the Code - not even as a rejected synonym of "binominal nomenclature" (which is its fate under the Code) - in spite of the fact that virtually all textbooks in biology refer to the Linnaean system that is used throughout most of biology as "binomial nomenclature." Nomenclature would have been far better served by accepting virtually universal custom in this context rather than by pretending it doesn't exist and attempting to substitute the dubiously superior term of "binominal nomenclature."

Protracted arguments several decades ago concluded by equating "binary" and "binomial" as referring to a two-part system of nomenclature, with two scientific names for any species-group name or names. Since custom had so long so interpreted the meaning of "binomial nomenclature," in the interest of stability and the good will of the zoological community that terminology should have been preserved. It would not have interfered in any way with the concepts of the binomen and trinomen.

At least the current disposition of the term should not have been avoided in this edition of the Code.

3. Modern biology entails recognition that two kingdoms do not properly reflect reality; five kingdoms (Monera, Protista, Fungi, Plantae, Animalia) more accurately portray life forms. The Code's glossary implies that the two-kingdom concept has been maintained. A more modern perspective needs to be incorporated in the Code.

4. Although the Constitution of the Commission is provided in full, the Bylaws are merely mentioned (Art. 82). They are given in full in the Bulletin of Zoological Nomenclature (Nov. 1977, vol. 34 (3):176-184), but should have been included as one of the appendices of the Code, as was the Constitution.

5. Curiously, the titles of the List and the Index (for conserved and rejected names, respectively) of family-group names are properly titled Official List and Official Index of Family-Group Names in Zoology, but those for genus-group and species-group names are merely entitled Generic and Specific. The more inclusive terms would be more appropriate.

6. The term "nomen oblitum" is essentially restricted to applications authorized by the earlier edition of the Code, between Nov. 6, 1961, and Jan. 1, 1973, referring to "forgotten names." No specific terms for such names at present is noted; nomen neglectum would be appropriate.

7. "Correction" of erroneous original statements of type locality is recommended, but it would have been useful to recommend "restriction" also. For example, a type locality statement of "America" might be correct, but certainly in need of restriction. Correction and restriction are not the same, unless explicitly so defined (and neither is).

8. The term and concept of "nomen veneratum" would have been useful additions, extrapolated from Art. 79, in which it is specified that names in uncontested use for the immediately preceding 50 years or more by at least five different authors in at least ten publications are eligible for consideration for conservation if an earlier synonym is discovered. Indeed, a Principle of Nomina Venerata could well be a proper guiding provision of the Code.

9. Although "rejection" and "suppression" of names are defined in the glossary, the potential nomenclatural roles of such names, on the appropriate Official Index, are not made clear. The names are not rendered unavailable, hence ineligible in any type role, even though they may never be valid, unless so specified. They can serve in certain roles, as types for example, unless ruled to the contrary.

10. The term "onomatophore" is not mentioned in the Code, although it has been commonly used in nomenclatural parlance for several decades. It would not be out of order for the Code to take cognizance of popular terms, even those not adopted for use under the Code. The substitute for onomatophore adopted in this edition is "name-bearing type" - a rather clumsy although self-explanatory term. If a Latin term were preferred over the Green onomatophore, a term such as denominotype might be useful.

11. Another popular term not mentioned in the Code is "hypodigm," of the same length of history as the preceding. Instead, "type series" is adopted, although it is not necessarily the same as hypodigm, which includes all material, whether designated as types or not, in which the concept of a new species-group taxon is based. As a widely used term, its equivalence should be indicated in the Code.

12. The term "epithet" was extensively discussed in recent issues of the Bulletin of Zoological Nomenclature as a collective term for species-group names. In earlier years (even in earlier editions of the Code), the term "trivial names" was similarly used for either specific names alone, or as a collective for species-group names irrespective of rank. Neither term is mentioned in the current edition, but obviously both should be.

13. Junior homonyms for valid species are, in the absence of any available synonyms, to be replaced by nomina nova fide, Art. 60(a). In reality, more flexibility in such circumstances exists than is admitted: the junior homonym may be replaced by a taxon (species, etc.) novum, thereby avoiding fixation of the name by the same type as that of the junior homonym. A nomen novum, on the contrary, perpetuates the same "name-bearing type" as belongs to the junior homonym. The Code should note the existence of these two alternatives, and make clear the differences between them.

14. Many taxonomists in the past have used the term "occupied" in essentially the same context as the term "available" as long used in the Code. The equivalence of the two terms should be specified.

15. Although paratypes and paralectotypes are no longer regarded as mandatory alternative name-bearers in case of absence of the holotype or lectotype, neither are they excluded from consideration, and in most cases would undoubtedly receive special consideration for neotype selection. However, if a proposer of a new species-group taxon considers certain paratypes as wholly inappropriate even to serve as neotypes, such indication should be admitted as a legitimate nomenclatural act. The term hypoparatype conveys that message, and should be incorporated in the Code at least as a recommendation.

16. The term "synonymy" refers, in one context, literally to a list of synonyms, and is so defined in the Code. However, the term is commonly used in taxonomy in reference to a list of all usages of all synonyms. Such a list is more properly designated a "synonymy and chresonymy," the latter term not included in the Code, but explicitly referring simply to the usages of given synonyms (or of all synonyms). The Code should recognize and differentiate between these two terms.

17. Although the taxonomic "definition" is defined in the Glossary, "diagnosis" is not, yet both terms are important in systematics.

18. Although the term "exerge" is used in Art. 6B, it is nowhere defined; the context in that article does make plain that it refers to "supersubspecies" - a concept similar to that of "superspecies," also used there but not defined in the Glossary.

19. In a book so vital to zoological comprehension, its source and cost should be indicated inside its covers, so that anyone discovering through perusal that the book should be obtained for personal use will have the essential information for purchase readily at hand.

—Hobart M. Smith, *Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado 80309-0334.*

Received: 6 September 1985

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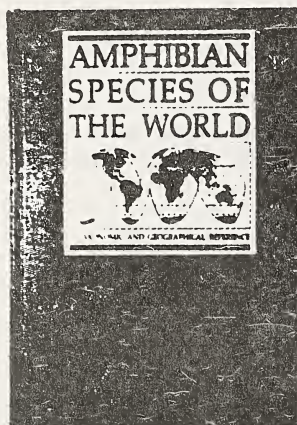
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Rana dauchina Chang, 1933. China J. 18
TYPE(s): Not traced.
TYPE LOCALITY: Hungchun-ping, Mo
DISTRIBUTION: Sichuan, China.
COMMENT: In the subgenus *Hylarana*
which it differs in mating call
replacement name for *Rana* m
Zool. Ser. 8, Fiel

Rana debussyi van Kampen, 1910.
TYPE(s): Holotype: ZMA; now
TYPE LOCALITY: Deli, Sumatra;
Sumatra, Indonesia", by
DISTRIBUTION: Batak Mountain
COMMENT: In the subgenus *H*

Rana delacouri Angel, 1928. Bu
TYPE(s): Holotype: MNHN
TYPE LOCALITY: Bac-Kan (T
DISTRIBUTION: Known only
SUBGENUS: *Paa*

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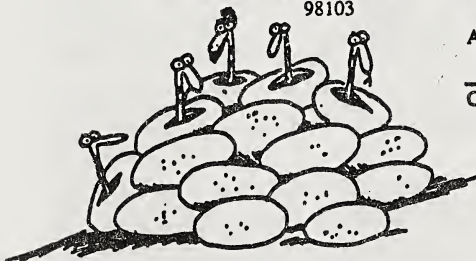
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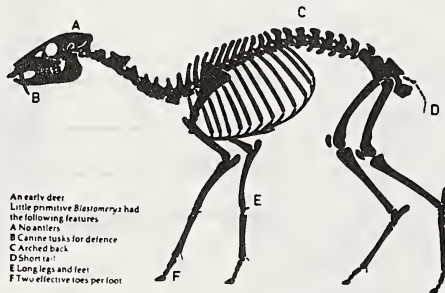
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REVIEWS AND NOTES:

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DAVID LAMBERT has written more than 50 popular, educational books, including seven on dinosaurs and three on prehistoric life. He holds an M.A. degree from the University of Cambridge and has worked as an editor with Rathbone Books, London, and editorial director for Educational Research Publications, London. Titles of books he has authored include A Field Guide to Dinosaurs, Dinosaur World, and The Active Earth.

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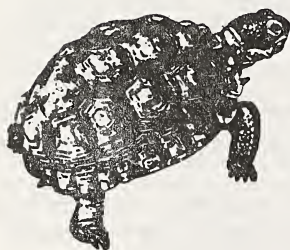
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